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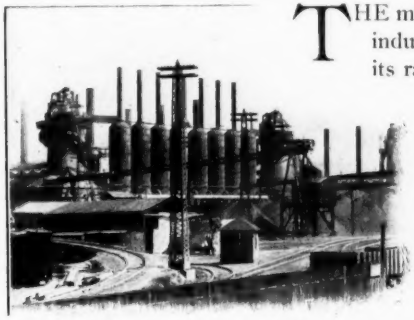
ORE-HANDLING MACHINERY ON THE AMERICAN GREAT LAKES.

By James N. Hatch.

It has been repeatedly pointed out that the United States owe their supremacy in steel making to mechanical genius rather than to physical endowments. Intensification of working, labor-saving methods, the utmost practicable development of mechanical devices for handling and transport, have more than overbalanced high wages and wide territorial separation of ores and fuel. Mr. Hatch treats the most striking features of the system for carrying the crude materials to the furnaces. Another paper now in preparation by a leading American authority on blast-furnace practice will supplement this by exhibiting the extension of similar methods within the iron works.—THE EDITORS.



THE magnitude of the iron and steel industry in the United States and its rapid and steady growth have not only kept pace with, but have been largely responsible for, the wonderful development in all other lines of advancement. Not alone in America but in all the great markets of the world American iron and steel are becoming close competitors of the foreign product. When we consider that labor is fifty to one hundred per cent. higher than in Europe, and that the distances through which the materials and product must be transported are often much greater, this condition may seem anomalous. But besides the advantages in material resources, both in fuel and ore,

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not the least among the reasons is the improved machinery used in the United States. So proficient has the Yankee become in the design of machinery for mining, loading, transporting, and unloading ore and coal that one of the chief articles of American export is this improved class of machinery.

Since the discovery of the rich ore in the Lake Superior region about fifty years ago, the problem of transportation has become much more important than previously, when the furnaces were located near the mines. The center of the iron industry had been moving westward, as the richer ores and better coal fields were discovered. But when the iron industry was almost replaced by the much greater steel industry, and it was found that the Connellsville coke was far superior to any other in the country for making steel, the attraction of this excellent coke on the one hand and of the rich bessemer ore from the lake region on the other, soon made it manifest that the center of the steel-producing region must be somewhere on a line drawn between these two points of attraction. Since it takes practically a ton of coke to a ton of ore, it might seem to make little difference at what point between these two great points of attraction the mills were located. But as a great deal of fuel is needed in the

95-TON SHOVEL HANDLING ORE FROM THE BANK TO RAILWAY CARS, MINNESOTA RANGES.
Vulcan Iron Works.

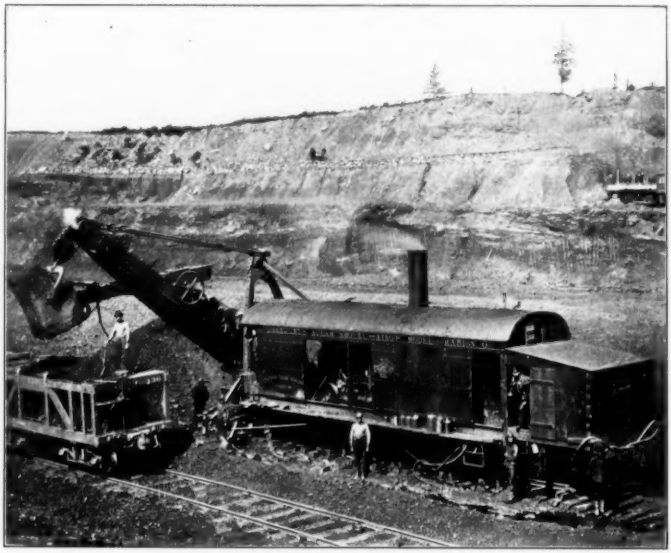
LOADING ORE FROM A MINNESOTA MINE INTO CARS FOR SHIPMENT.
Bucyrus Company's steam shovel.

mills beside the coke, it is well to be located near good coal mines. The center had for other reasons been earlier located in the Pittsburg district, and there was no good reason why it should not remain there.

The location of the furnaces settled, the problem of getting the ore to them soon began to call forth the ingenuity of many inventors. When the shipments of ore from the Superior region first began, the methods used in mining were still crude and expensive. The pick and shovel and hand drill were then the best-known implements for dislodging the ore. In deep mines the ore was lifted out of the shaft by means of derricks and horse whims; where it was possible to enter on the level, wheel-barrows and carts were employed. A plank road from the mines to the docks was constructed soon after the mines were opened, and for a number of years, wagons hauled over these roads all the ore shipped down the lakes.

Power drills driven by steam or compressed air were introduced in 1878. Tram cars were first used about 1880. In 1857 a railroad was built from Marquette to the adjacent mines. Since then the discovery of new mines, the invention of new methods of mining, and the improved hoisting machinery used at the mines, have reduced the cost to such an extent that ore that would have sold for several

dollars a ton fifty years ago has of late been sold at the mines, ready for shipment, as low as 72 cents per ton. Machinery is used for almost every move the ore makes, from the time it is dislodged from the bank till it is piled up as finished steel. About 30 per cent. of the



STEAM SHOVEL AT THE MINES OF THE OLIVER IRON MINING CO., MT. IRON, MINN.
Marion Steam Shovel Co.

Superior ore is mined in what is known as surface mines. In this method the top soil and rock are stripped off and conveyed away, leaving the ore exposed in the form of great banks, looking much like banks of yellow or red loam. A steam shovel is then put to work against this bank that will scoop up 5½ tons to the bucketful. A train of cars is shifted along a track parallel to the one on which the steam shovel stands, and the shovel bucket is dumped into these cars.

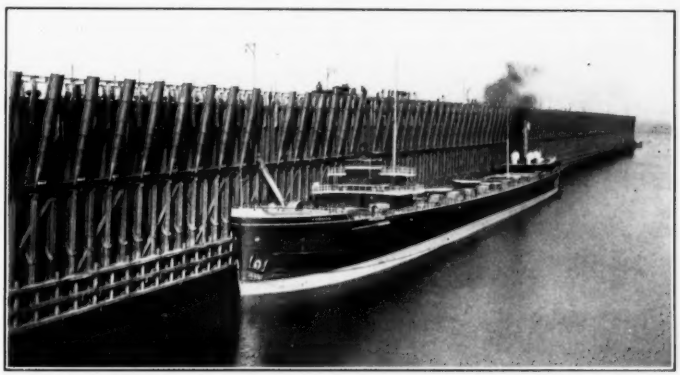
The other 70 per cent. of ore is taken from deep mines where a shaft is sunk, often to a depth of a thousand or fifteen hundred feet. But even with these deep mines the ore can be obtained very cheaply, since close competition has forced the operator to be on the watch constantly ready to seize every possible improvement that would tend to reduce the cost of production.

The output from the Lake Superior region for the year 1900 is,

as given in the table below, 18,570,315 tons. This table is interesting in showing the increase from year to year for the last fifty years. It is interesting to note the great advance in the shipment after 1855. This was the year in which the first locks at Sault Ste. Marie were finished and ready for use. Also notice, in 1861 during the war, the great falling off in lake shipments.

PRODUCTION OF IRON ORE IN THE LAKE REGION.

Year.	Tons.	Year.	Tons.	Year.	Tons.
Previous to 1854	75,083	1869	639,097	1885	2,487,446
1854	3,000	1870	859 507	1886	3,637,753
1855	1,449	1871	813,984	1887	4 729,352
1856	6,790	1872	948,533	1888	5,007,596
1857	25,646	1873	1,195,234	1889	7,588,076
1858	22,876	1874	899,834	1890	8,982,531
1859	68,632	1875	881,166	1891	7,661,587
1860	114,410	1876	993,311	1892	9,071,082
1861	49,909	1877	1,025,129	1893	6,058,955
1862	124,169	1878	1,127,583	1894	7,748,223
1863	203,655	1879	1,420,745	1895	10,429,037
1864	247,059	1880	1,962,477	1896	9,934.828
1865	193,758	1881	2,323,640	1897	12,457,002
1866	296,713	1882	2,932,953	1898	14,300,000
1867	565,504	1883	2,580,223	1899	17,901,358
1868	510,522	1884	2 321,880	1900	18,570,315



ORE PIERS AT ESCANABA, MICH., WITH ORE STEAMER LOADING.

When the only method of transporting ore from the mines to the docks was by means of wagons, four or five miles was about as far as it was practicable to bring the ore. Now it is transported over a hundred miles from the Minnesota mines to the lake ports. When these great ore trains arrive at the port they are run out on the dock and the ore dropped out through the bottom of the car into the

pockets of the ore docks, whence it is afterward let out through chutes into the vessels. These docks have been constructed at an immense expense, and with these, as well as with the other labor-saving devices, every improvement possible has been made to save running expense. It is said that these docks have an aggregate length of over five miles and a storage capacity of 660,000 tons, one single dock being 2,300 feet long, with a capacity of 57,600 tons.

With the present dock equipment a vessel of 5,000 to 8,000 tons can be loaded in three or four hours. It is no uncommon occurrence to

PENNSYLVANIA COMPANY'S COAL TRESTLE AT ERIE, PA.

load a boat of 2,000 tons of ore in one and a half hours. The dock at Duluth cost $425,000.* Fifty years ago the ore was dumped from the wagon upon piles along the wharf. When a vessel came in to load an army of men were put to work shovelling the ore into wheelbarrows, wheeling it along plank runs out onto the vessel, and dumping it into the hold. It then required twenty men working 10 hours per day 10 days to load a vessel of 1,000 tons, at a cost of 40 cents

* "The ore docks of the Duluth, Missabe and Northern Company at Duluth made a record of 64,000 tons moved in twenty-four hours Monday last (June 10). This record has never been approached on the lakes, and is equal to a season's movement of 13,000,000 tons. It was taken from the docks into fourteen large boats, and the average cargo was 4,571 gross tons."

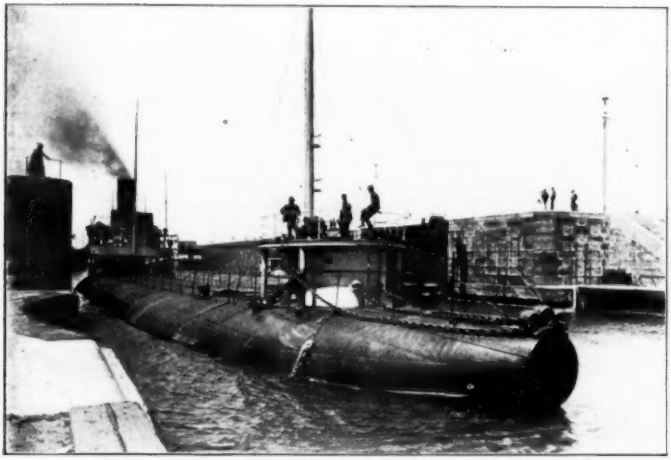
per ton. Now a vessel five times as large can be loaded in two or three hours, at so small a cost that it is hardly worth considering. Of course the interest on the investment in dock equipment must be considered, but this is more than counterbalanced by the fact that with these new methods the vessels, in which there is also an immense capital invested, are kept on the lakes almost all the time instead of lying in the harbor waiting for their load. Also twenty or thirty vessels can now be loaded in the same harbor space where one could have been loaded by the old system. It is doubtful if the new docks are much more expensive per ton of ore handled than the old ones were.

While these improvements in various lines have been put into operation, the shipping methods have not been behind in bettering their carrying facilities. A glance at the table below will give an idea of how these improvements have reduced lake freights:

Years.	Shipment.	Rates.		Years.	Shipment.	Rates.	
		Marquette	Escanaba.			Marquette.	Escanaba.
1854	3,000			1872	948,533	$2.85-$6.60	$2.00-$5.25
1855	1,449			1873	1,195,234	3.25- 4.00	2.30- 3.00
1856	6,790	$3.00-		1874	899,934	1.60- 2.50	1.30- 1.40
1857	25,646	3.00-		1875	881,166	1.30- 2.50	1.10- 1.30
1858	22,876	2.00-$2.50		1876	933,311	1.25- 2.20	.70- 1.40
1859	68,832	2.00- 2.50		1877	1,625,129	1.25- 2.00	.65- 1.50
1860	114,410	2.00- 2.50		1878	1,127,583	1.00- 1.50	.60- 1.15
1861	49,909	2.00- 3.00		1879	1,420,745	1.25- 3.00	.70- 2.10
1862	124,169	2.25- 4.50		1880	1,948,334	2.00- 2.75	1.50- 2.00
1863	203,655	3.00- 4.00		1881	2,125,729	2.00- 2.30	1.00- 1.60
1864	247,059	3.00- 5.00		1882	2,656,933	1.25- 2.00	.90- 1.40
1865	193,758	2.05- 5.00		1883	2,518,048	1.30- 1.75	.90- 1.50
1866	296,713	2.75- 6.50	$2.50-$5.75	1884	2,225,146	1.00	.65
1867	565,504	2.00- 4.00	1.05- 3.05	1885	2,205,190	1.40	1.00
1868	510,522	2.25- 3.25	1.06- 2.06	1886	3,179,511	1.75	1.35
1869	639,097	2.75- 4.50	1.05- 2.05	1887	3,934,339	2.15	1.75
1870	859,507	2.05- 3.25	1.65- 2.50	1888	4,113,803	1.10- 1.15	.90- 1.40
1871	813,984	2.05- 4.00	1.50- 2.50	1889	5,856,169	.90- 1.25	.90- 1.25
				1890	7,141,650	1.25- 1.10	1.10- 1.00

These rates are simply the toll charges from the upper lake ports to the lower lake ports, and do not include dock charges, loading, or unloading. It will be noticed that the rates in 1890 were only about —one-third the rates of 1856. After 1890 the rates fell slightly, but with the wave of prosperity they rose again to an average of about $1.00 per ton. In 1898, owing to the great increase in the carrying capacity of lake vessels, freight rates dropped to 60 cents per ton and are not likely again materially to exceed that figure.* One element

* The 20th Annual Report of the United States Geological Survey says: "It is claimed that owing to the increased draught, larger vessels, more economical engines, prompt loading



A WHALEBACK ORE CARRIER IN THE POE LOCK, SAULT STE. MARIE, MICH.

that has helped to lower freight rates on ore, is the rapid coal-loading devices now employed on the Lake Erie docks. A vessel that comes down the lakes loaded with ore can return loaded with coal, without a long delay to wait for her cargo.

In the last two years the sizes of lake vessels have been very materially increased. Steel vessels 500 feet in length and of over 8,000-tons burden are now being used in the ore trade to an advantage, although ten years ago it was not believed that such a vessel would ever be used on the Great Lakes.

Rapid methods of loading and very good carrying facilities had been in vogue for some years before any good method of unloading the ore from the vessels had been put into practice. And it may be said that, even now, unloading machinery is only in its infancy. However, there has been for several years machinery in use that is such an improvement over the old methods that it has really marked a new era in the ore-handling industry.

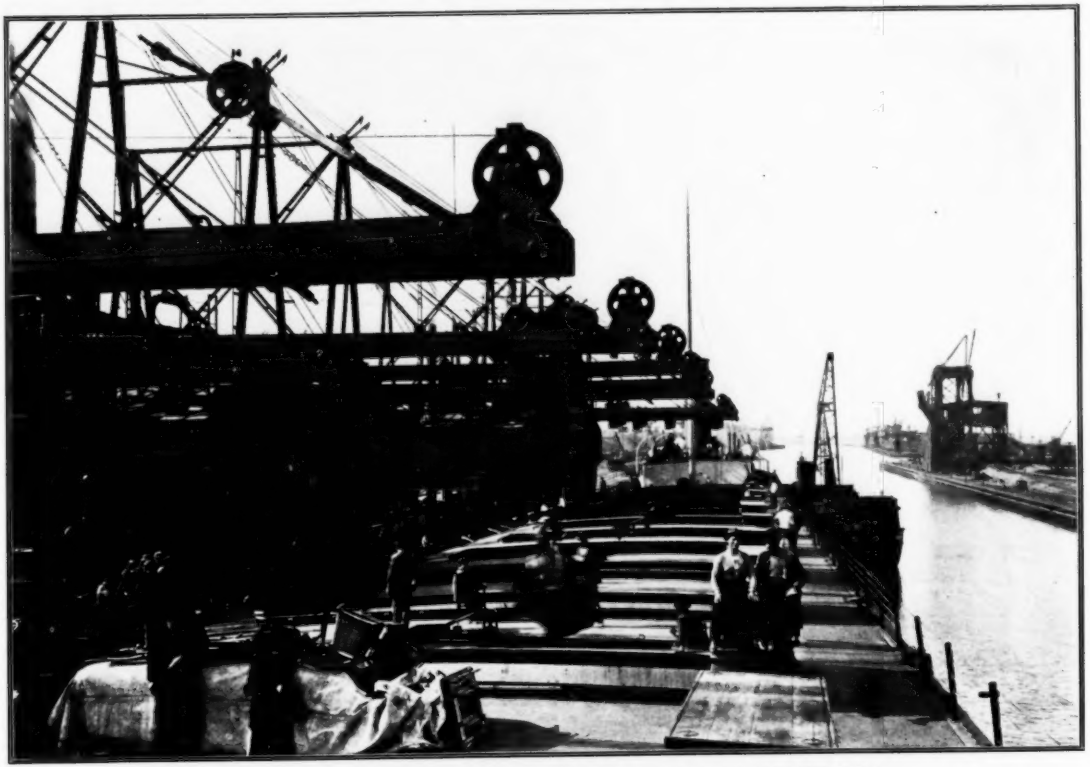
One of the pioneer machines, that proved a success, is what is known as the bridge tramway. These machines are made like a long bridge with a hinged cantilever projection, as shown in the cut. Along the lower chord of this bridge, which is twenty-five or thirty feet from the ground, is a track on which a small car or trolley runs. A bucket hangs from this trolley; this bucket can be raised or lowered

and discharging, etc., the transportation companies earn as much on the long hauls at the latter rate (60 cents) as they earned in former times on double the amount now received."

any desired distance at any point along the line of travel. The bucket used holds about a ton of ore and is filled in the vessel by men with shovels. These buckets have rollers under them, by which they can be moved about in the vessel. When a bucket is full the trolley is run out over the hold, a hook lowers and receives the bale of the bucket, the bucket is raised, and the trolley then traversed back to where it is desired to dump the ore. The load may either be dumped into cars that can be placed under the bridge, or onto stock piles three or four hundred feet from the vessel. All the operations of the machine are controlled by one man, who is located over the engine at the end of the bridge away from the dock. All these operations are very rapid, so that when everything is working properly a bucket can make a trip a minute. Several buckets can be loading at once in the hold. The large lake vessels have ten to fifteen hatches, so that at least a dozen tramways can work over one vessel. It is thus seen that 500 tons per hour can easily be handled. This would unload any ordinary vessel in one day.

The direct unloader or fast plant is similar in many respects to the bridge tramways, but is used simply for unloading into cars. It is more rapid, both in trolley operation and in movement along the dock, than the bridge tramway, but has a trolley travel of only about one hundred feet. The cut shows a set of these machines on the Conneaut dock. There are three machines operating twelve trolleys.

SPAR DECK AND HATCHES OF THE LAKE ORE CARRIER ANGELINE, LOOKING AFT FROM THE BRIDGE.



UNLOADING AN ORE VESSEL BY FAST PLANT DIRECT INTO CARS, CONNEAUT, OHIO.

Across the slip is the car-dumping plant. Beyond that, on the right bank, the Hulett unloaders. In the distance on the left the bridge tramways are seen. Brown Hoisting Machinery Co.

With these machines they have unloaded 6,000 tons of ore in ten hours. Either of the above styles of machines may be moved along the dock so as to stop over any hatch of any vessel.

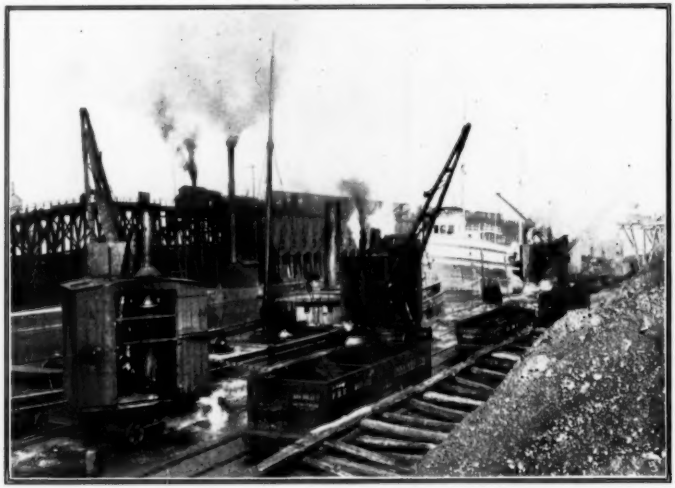
The newest unloading machine is what is known as the Hulett unloader. In the illustration there are three of these machines shown, one with the mast down in the hold of the vessel, the second with the mast withdrawn and the bucket full of ore, the third with the bucket open after having dropped the ore into the car. The bucket is of the clam-shell type. It drops upon the pile of ore in the vessel and in closing automatically scoops itself full of ore. It has a capacity of 10 tons. By means of the walking beam, the mast with the bucket

HULETT UNLOADER, CONNEAUT ORE DOCKS, ON LAKE ERIE.

attached to the bottom is lowered into the vessel. Hydraulic mechanism turns the bucket through an entire circle while down in the vessel, giving it a sweep of about nine feet, which is half the distance to the center of the next hatch. As the bucket closes it fills, and is then withdrawn and can be dumped into the cars or into conveyors which carry the ore back into stock piles. The whole machine is of steel and is of most ingenious design. It can be travelled along parallel to the dock, as it rests on wheels, on rails, and can thus stop over the hatch of any vessel. But four men are required to operate a machine. The man that controls the movement rides on the mast just over the bucket and goes into the hold with it. The capacity of a machine is about 200

tons per hour, and it will take 90 per cent. of the ore, leaving only 10 per cent. to be shovelled. So it will be seen that four or five of these machines would unload a vessel of 6,000 or 7,000 tons in less than a day without the slightest trouble. These machines have been at work on the Conneaut docks for over a year, and while it may be said to be only in the embryonic stages of development, it is without doubt a mechanical success.

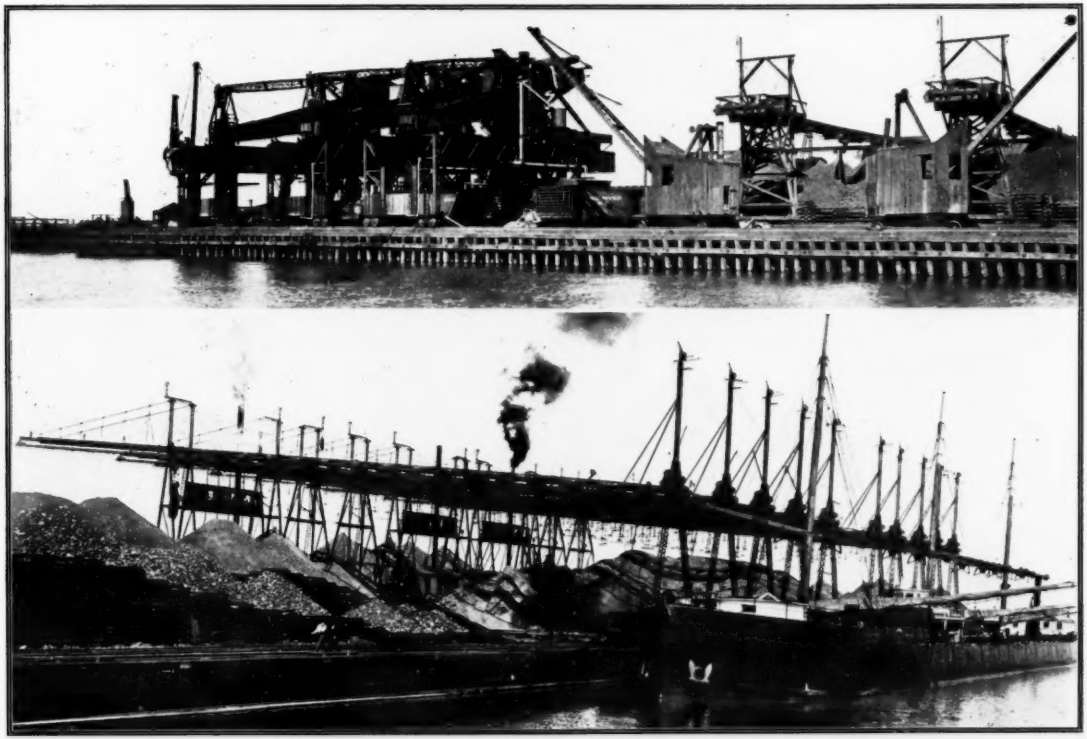
That the improvement in unloading machinery has been slower than the improvements in other branches of transportation cannot be denied, but that there is a very marked improvement is no less true.



"WHIRLEYS" UNLOADING ORE ON THE ORE PIERS OF THE PENNSYLVANIA RAILROAD, ERIE, PA.

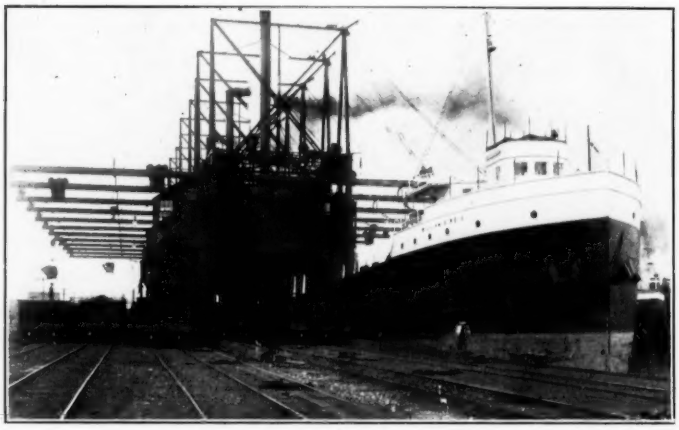
With the methods of fifty years ago, the ore was lifted out of the hold by hand, wheeled to the stock piles in barrows, and there dumped, to be again handled before it was aboard the cars ready to go inland. When a vessel tied up at the dock, although the largest vessels then would hardly carry a thousand tons, it was with the expectation of staying weeks instead of hours. For it then would have taken ten men working ten hours per day about two weeks to wheel the ore from the ship to the stock pile after it was lifted out of the hold ready to load into the barrows. And although wages were lower then than now, it would have cost about three times as much per ton to unload the boat.

Here again is seen the great saving in wharf room, for a dozen



CHARACTERISTIC ORE-UNLOADING INSTALLATIONS AT LAKE ERIE PORTS.

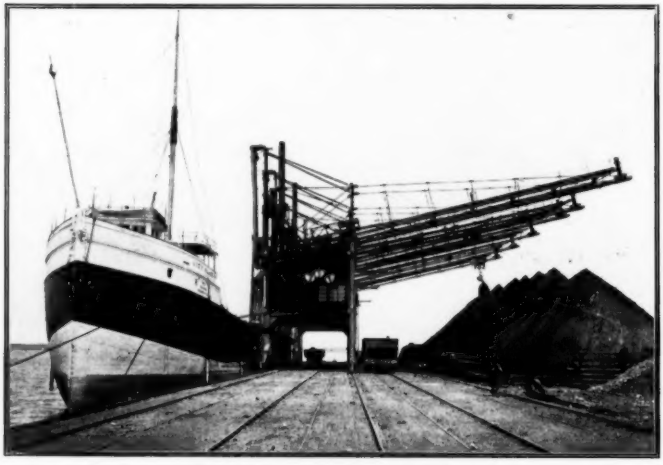
Above are shown the Hulett unloaders at Conneaut, Ohio, illustrated in a closer view on page 667. The plant below is at the docks of the L S. & M. S. Ry., Ashtabula, Ohio, and exhibits the Brown Hoisting Machinery Co.'s bridge tramways discharging a lake ore carrier.



DIRECT UNLOADING MACHINERY ON THE CONNEAUT DOCK.

Known as the "fast plant," for discharging ore cargoes from the steamer directly into the railway cars.

vessels can unload where one did formerly. Very recently another innovation has been introduced to avoid delay. Until within a year, after a vessel was unloaded she had to put into a coaling dock to coal for the next trip. Now there is being introduced a mammoth fueler.



HANNA'S ORE PLANT, ERIE, PA.

Brown bridge tramways discharging ore from steamer to stock pile.

This is a sort of self-propelling barge with pockets for carrying 300 tons of coal. When the ore vessel ties up and begins to unload, one of

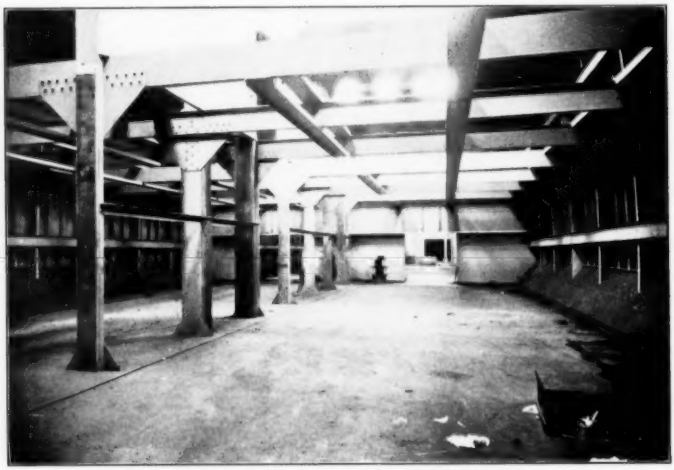
A FUELING LIGHTER WITH CLAM-SHELL HOIST, HARBOR OF ASHTABULA, OHIO.
Part of the system for rapid clearance of the lake fleets at their coaling ports.

the fuelers comes alongside and transfers 200 or 250 tons of coal from its pockets into the vessel. This transfer is made by means of a crane and a two-ton bucket.

IRON-ORE RECEIPTS AT LAKE ERIE PORTS—GROSS TONS.

PORTS	1900	1899	1898	1897	1896	1895
Toledo	645,147	792,348	414,012	416,438	301,794	260,730
Sandusky	154,542	87,499	136,209	79,792	58,667	12,361
Huron	321,914	263 600	126,755	198,231	226,515	146 442
Lorain	1,090,235	1,112,946	536,086	355,188	191,445	214,219
Cleveland	3,376,644	3,222,582	2,645,318	2,456,704	2,313,170	2,312,370
Fairport	1,085,554	1,241,013	912,879	1,008,340	941,446	914,617
Ashtabula	3,709,486	3,341,526	2,684,563	3,001,914	2,272,822	2,474,791
Conneaut	2,556,631	2,320,696	1,404,169	495,327	327,623	244,967
Erie	1,240,715	1,309,961	1,092,364	1 311,526	847,849	811,989
Buffalo, Tonawanda	1,616,919	1,530,016	1,075,975	797,446	545,101	719,742
Total	15,797,787	15,222,187	11,028,321	10,120,906	8,026,432	8,112,228

The principle lower lake ports that receive iron ore, with the amount received by each, are listed in the table on the preceding page, taken from *The Iron Trade Review*.



THE HOLD OF AN ORE STEAMER ON THE AMERICAN GREAT LAKES.

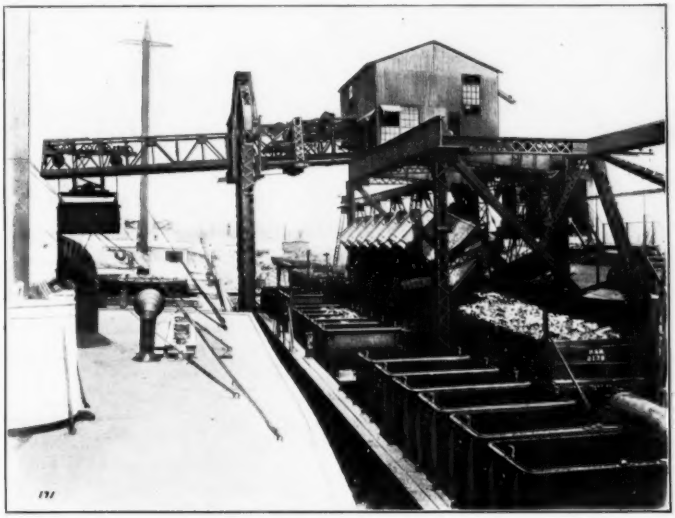
A reason why it is imperative that ore should be handled rapidly on the lakes is that the shipping season extends over about half of the year only; and for this reason also it is necessary to store an immense amount of ore in stock pile during the summer, to be distributed inland during the winter. The table given below gives the amount of ore remaining in these stock piles on December first for the past six years:

IRON ORE ON LAKE ERIE DOCK, DEC. 1—GROSS TONS

PORTS	1900	1899	1898	1897	1896	1895
Toledo	242,375	186,422	146,568	194,644	115,959	111,132
Sandusky	95,111	23,184	48,500	84,786	59,491	34,375
Huron	211,377	164,480	159,982	230,029	200,075	101,000
Lorain	251,838	337,822	324,034	317,509	231,288	224,264
Cleveland	1,337,445	1,200,806	1,175,970	1,478,355	1,419,311	1,200,792
Fairport	611,717	692,147	719,794	825,312	773,905	605,470
Ashtabula	1,811,459	1,902,599	1,732,671	1,835,694	1,441,666	1,301,382
Conneaut	630,514	468,808	288,101	360,895	275,800	292,468
Erie	480,734	361,335	439,167	484,871	355,222	335,718
Buffalo	232,100	192,681	121,620	111,660	82,267	207,199
Total	5,904,670	5,530,283	5,136,407	5,923,755	4,954,984	4,415,712

After the ore has been unloaded from the ships to the dock, either into the cars or upon the stock piles, in many cases it still has quite a journey to the mills where it is to be made into commercial iron. It is carried inland over two hundred miles and made into steel which, in the finished state, is again shipped west to compete with that made at the western mills.

The Pittsburg and Conneaut Dock Company at Conneaut, Ohio, owned by the Carnegie Company, is one of the best-equipped docks in the country, which (it goes without saying) means is one of the best in the world. The facilities for transporting the ore by train from the docks to the furnaces at Pittsburg are unsurpassed, and the methods of unloading at the destination are well-worth noticing.



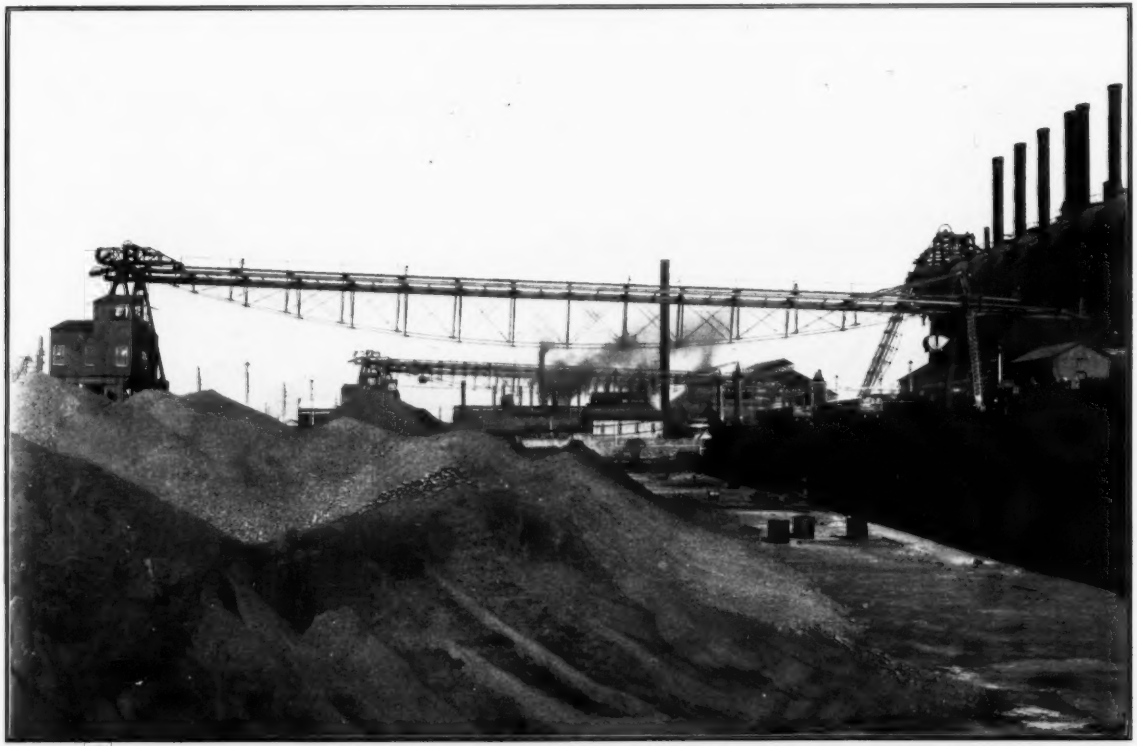
A CAR-DUMPING PLANT AT A LAKE PORT.

The installation shown is specially designed to place coal aboard of vessels without breakage and to trim as it loads. The railway car is picked up bodily, overturned, and emptied through the multiple hopper into the buckets, which are then taken by the crane, lowered into the hold, and emptied. The crane is moveable, serving many hatches and thus trimming the cargo it puts aboard. Brown Hoisting Machinery Co.

The Pittsburg Bessemer and Lake Erie Railway, owned by the steel company, is a new road built exclusively for the ore and coal trade. There are used some of the heaviest engines ever built, hauling a long train of immense steel gondola hopper cars holding 50 tons of ore apiece. This road forms a direct line from Conneaut to Pitts-

THE CAR-DUMPING PLANT, LOOKING ALONG THE TRACK.

burg. When these ore trains reach the Carnegie furnaces they must be unloaded as quickly as possible, to save cars and to save storage track room. The company has now in process of construction at its furnaces at Rankin, Pa., (across the river from Homestead), one of the largest car-unloading and storage plants ever built. When the loaded train comes into the yards, the cars are run one by one upon a car tipple. This machine is of Brown Hoisting Machinery type and is the largest one ever built by that company. The cars are stopped on the platform of the tipple and clamped down to the track. The tipple is then set in motion, lifting a section of the track, loaded car and all, and turning it through a vertical circle until the car is turned upside down and the 50 tons, more or less, of coal are emptied into



ORE BRIDGE AT THE CARNEGIE FURNACES.

The plant shown is the smaller one, first erected, handling 5-ton buckets. The latest installation uses 20-ton buckets. Brown Hoisting Machinery Co.

bucket cars, which stand on a track alongside the tipple and hold 22,400 pounds apiece. This machine is guaranteed to handle 300 cars in a day of 10 hours.

These bucket cars are hauled away to the side of the stock yard and stopped under the cantilever of the largest bridge tramway ever built. This tramway has a trolley travel of about 500 feet, and can pick up the bucket with its load of 22,400 pounds from the car, and carry it to any part of the yards. This load of over 10 tons can be lifted from the ground at the rate of 250 feet per minute, can be moved across the bridge at a speed of 800 to 900 feet per minute, and the whole machine, load and all, can be moved up or down the yards at a speed of 75 to 100 feet per minute. There are two of these tramways in this yard, and these are intended to handle the ore as fast as the tipple can unload it.

Every effort in every department is being exerted, and no money is being spared to render all this ore-handling apparatus the most rapid it is possible for American ingenuity to devise. And how far success has been attained may be realized from the fact that it is now possible within ten days from the time the ore is taken from the Lake Superior mines to have it for sale in Pittsburg in the form of finished steel.

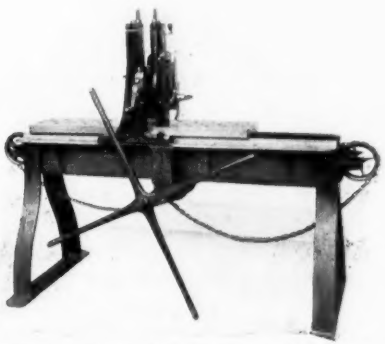
The engravings accompanying this article are for the most part from photographs supplied by the Detroit Photographic Company. For the views of the car-dumping plant and the ore bridges at the Carnegie furnaces we are indebted to the courtesy of the Brown Hoisting Machinery Company.

A PRACTICAL VIEW OF AMERICAN MACHINE-SHOP CONDITIONS.

By M. Cokely.

Unreasonable and irresponsible as labor has shown itself, it is certain that stable adjustment of relations between employer and employee can be effected only on a basis of mutual reason, of reciprocal justice and responsibility, and of common-sense recognition, by both sides, of the trend of evolution and the logic of industrial economy. If trade unionism cannot adapt itself to or if labor management will not be guided by these principles, each will fail. Collectivism, even backed by organized force, is as hopeless in the labor market as it is in the social system. Success comes through the full recognition of individual rights and free play of individual abilities.

Mr. Cokely is a specialist in the betterment of factory conditions—a close student of the factory worker. The striking feature of his argument is his clear presentation of the workman as an observing, reasoning, and generally reasonable individual. His suggestions for dealing with him as an individual rather than *en bloc* will appeal by their fairness and eminent common sense. The article is particularly timely in view of the recent violent disturbance in labor conditions in so many of the works of the United States.—THE EDITORS.



IN considering the relations which should exist between employer and employee in industrial establishments, it is necessary to take into account their records and surroundings and the influence these exercise on character. The energy which the American workman has exhibited has not been equaled in any other part of the globe. This is true not only of the native-born but also of the naturalized foreigner. The latter soon becomes imbued with that all-pervading spirit of activity which is a recognized national American characteristic. How that spirit originated I am not prepared to explain. It may be due to race intermixture, to political or climatic conditions, or to all three; but this is positive—that the commingled races of people who have made the United States famous have emigrated to pretty much every other quarter of the earth but in no place have they developed

the same characteristics or produced the same results as they have within the boundaries of the United States. Suffice it to say that this peculiarity exists and that it is nurtured by the influence of example. It is a fact that the workman has been educated to a realization of the necessity of comfort and luxury. He is a witness of it and in touch with it nearly every hour of his life. In the mansion of his next-door neighbor, in the streets and in the conveyances that traverse them, he is side by side with it. As he travels through the country he sits in the midst of it, and throughout his whole existence affluence is constantly before his eyes. He sees the man with whom, perhaps, years before, he labored side by side as a workman, now in the possession of wealth and honor. He sees no barriers to the possession of wealth and position except those due to his own natural defects. There is no class distinction in America so clearly defined as to limit his ambition or efforts. Say what one may, there is a civilizing influence in luxury, judiciously enjoyed. The example has been set for him. On the record sheet of human ambition and honorable success he may place his mark at a point equal to the highest ever reached by man. The record sheet from that exalted point down to the bottom is covered by marks, clear and distinct, of varying degrees of success according to the ambition or ability of the individual or the circumstances under which he labored. That is the record of the American workingman. Amid such surroundings and with such incentives his heart must be imbued with a spirit which lifts him above the plane of a mere servant or that of the workman as it is understood in Europe. The position which has been productive of such results cannot be otherwise than dignified, and to maintain that dignity he must receive sufficient remuneration for his labor. In describing the record of the workman we have practically described that of his employer, the manufacturer, because the majority of the manufacturers are nothing more or less than successful American workingmen—men in whom that spirit of activity was intensified to such a degree that they became the employer instead of the employed. While, as a bed-rock principle, the workman on account of his record is entitled to the highest remuneration for his service, the manufacturer is entitled to the highest possible returns from his investment. The manner in which he has benefited science by his fearless acceptance of new principles—the glory which he has secured for his country by his indefatigable efforts and the daring of his enterprise—all this and much more to his credit entitles him to every consideration and respect. But in addition to this he possesses one more virtue which shines clear and brilliant above all others; that

is the generous spirit in which he reaches down and grasps the hand of the ambitious, thinking workman. There is the keynote to American industrial success. It is this spirit which has, to a great extent, nullified whatever evil there might be in the influence of over-zealous labor unions. In using the brains of his workmen to aid him, he has stimulated their inventive genius, encouraged their ambition, and inspired them with that feeling of self-reliance that brings to the surface that which is best in man.

While man's labor remains a purchasable commodity, there will always be conflicts between labor and capital, and for the person who can suggest some means by which these two elements can be brought sufficiently close together to prevent misunderstandings by viewing each other's contentions in the pure light of reason, there is no reward too great. In the pursuit of that object the employer should lead the way by managing his business in such a manner that he can afford to allow his workmen the highest remuneration for their labor. It is not a very pleasing sight, even for a workman, to see his employer's money squandered around the factory while he is "pinched" to supply it.

Looking at them as employer and employed, the manufacturer and his assistant, both animated by a spirit of justice and having in view one common ideal—that of National industrial success—let us follow them into the factory and see how it is possible to realize their ideal with the least amount of friction. The whole question of their relations hinges on the cost of production. As a result of their activity, the United States find themselves occupying a position in the industrial world to maintain which they must produce more cheaply than they have ever done before. Production has so far exceeded the requirements for home consumption that they are compelled to go into the foreign markets with their product and meet the foreign manufacturer on his own ground. Having once started in this direction they are compelled to continue or suffer an industrial depression. This is a point which should be brought home to the American workman so that he may understand the circumstances under which his employer is working and regulate his demands accordingly. As before stated, the controlling question is simply one of cheap production, and the capitalist has very wisely decided to accomplish that object by curtailing expenses at the general-expense end first. By the consolidation of business interests a much lower ratio of general expense results, consequently less necessity for reducing workmen's wages in order to meet competition successfully in foreign markets. Workers' wages should be the last thing to be touched unless they are glaringly out of

proportion. Every item of general expense should be so classified as to permit of the closest scrutiny at all times in order to detect excessive waste and to determine whether changes in methods and systems cannot be effected and greater economy practiced.

The next question to receive attention is that of engineering. If the product is machinery, is the design such as will admit of the least amount of outlay in labor and material in its production? Can a cheaper grade of material be used in certain unimportant parts? Can it be arranged for a less amount of finished surface, a less number of operations, and a less amount of handling and transferring? Can it be reduced in weight? Can it be so designed as to permit of being finished on a more simple grade of machine tools? In a word, has everything possible been done in designing that machinery to permit of the lowest possible cost of production without impairing either its artistic value, its durability, or its general efficiency?

If so, then take up the question of tools, appliances, anl facilities generally. Are the machine tools such as will give the greatest possible output, or will it pay to install special tools? If the product is a specialty, has the question of small special tools, such as jigs, templates, gauges, punches, dies, and attachments, by which production is promoted, been considered? Is the best quality of tool steel used for cutting tools? Is it such a grade as will stand the highest cutting speed, or is a cheap grade in use which will stand a speed of only thirty or forty feet per minute, while a steel can be bought in the open market that will stand eighty or a hundred, and in some cases more? Has the work been classified according to the skill required to perform it, and judiciously distributed among the tools on which it can be done by the cheaper grade of labor? Has the labor been properly classified according to the skill required on the work on which it is engaged, or are we using skilled mechanics on work that should be done by handymen or boys? There is hardly anything around a factory so destructive to profits as the employment of skilled mechanics on work that requires little more than muscular effort to perform; besides, it is an injustice to a large class of workmen who, perhaps through no fault of their own, have not had an opportunity to learn a trade and become skilled. It is my firm conviction that if a man has been skilled to that pitch of perfection where he considers himself above and beyond the reach of the common laborer, he should be employed, as far as possible, only on work worthy of his skill. We can appreciate the pride, if not the judgment of the molders on this point when as a rule they refuse to operate molding machines, considering it beneath their dignity.

Unfortunately, the same high sense of honor does not exist among the machinists. There is no reason why a laborer should not operate a machine tool so long as the work to be done requires little or no skill. It is not the machine a man operates that makes him a mechanic, but the skill required in the work that he performs. My sympathies are with the laborer who must live and be a respectable citizen on a dollar and a half or less a day. Fortunately, through the invention of automatic and semi-automatic machinery and the standardization and specialization of product, avenues have been created through which the common laborer of thirty or forty years ago has advanced himself to a higher position in the industrial world and what is left of the place he vacated is now occupied by what is considered an element of inferior ability from continental Europe. The common laborer of old is the handy-man of today, and he is just as essential as the skilled mechanic. We can find him through most American factories doing much of the work once done by the old all-around mechanic; and with the improved facilities which he uses he is doing it not only as well, but in greater abundance, thus elevating his own position as a workman and assisting his employer to bring his product within the reach of a greater number of consumers.

There is much to be gained by a judicious distribution of the work among the tools and a proper classification and organization of the help. Their movements also should receive close attention. In walking through a shop, it takes but a glance of the practiced eye to determine the actual condition of affairs in every department and the amount that is being lost through apathy. Fortunate is the manager who from a superficial observation can detect this and see whether tools are operated to their full capacity or whether apparent activity is feigned. There is no mistaking the eager, active, animating spirit that is visible in a well-governed factory—a factory in which every man knows his duty and understands that he will be held strictly responsible for the faithful performance of it.

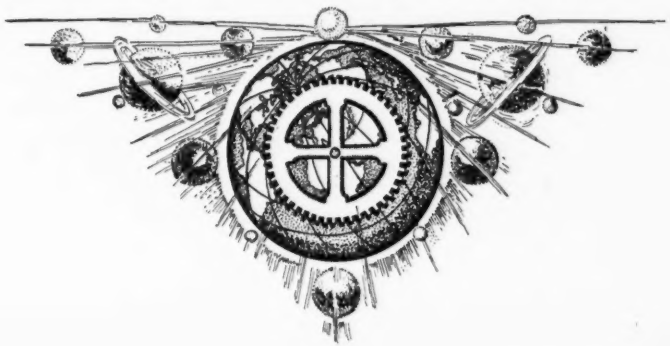
It is unfortunate that there should be such a lack of uniformity in the task required for a day's work. What is considered a day's work in one place is frequently but a half-a-day's work in another. This condition exists not only between different factories but often between departments of the same factory, thus producing a very bad influence on the help. While it seems impossible to improve this condition in so far as it relates to the different factories, with the more perfect organization of the manufacturers something might be done in that direction. In line with this comes the question of discipline and the observance of

factory rules. Too often this refers to the shops only. No department should be exempt. Discipline, like charity, should begin at home and the office is the place to start it, as that department should serve as a model for all others. Rules of discipline should be as few as possible, but there should be a strict enforcement of those few. In some shops notices are posted at every turn notifying the help that unless they do, or do not do, so-and-so they will be immediately discharged. It is my experience that in places where notices carrying this terrifying threat are most numerous, discipline is most lax, because the threat is seldom carried out. A plain statement of what is required of employees and an example made of the first deliberate violation will be much more effective. Less threats and more dismissals will be much more beneficial, because the help will soon realize that when a rule is issued it is going to be enforced, and they will govern themselves accordingly. Discipline should not be administered so as to make men feel as though they were criminals by the enforcement of useless irritating restrictions, but rather to inspire them with a knowledge of that conduct which is necessary to the success of their employer's business.

Next in order is the prevention of waste in material, supplies, etc., and to govern this requires a knowledge of the most modern practice. What is frequently considered as waste in one factory is a source of revenue in another. Great care should be exercised not only in the purchase of material in such form, quantity, and quality as will give the most economical results, but in the final disposition of the scrap and refuse generally. In the foundry, facilities for extracting the shot from the cupola dump have been made so complete that the operation is one of the best paying features about that department, and in tests which I witnessed when the shot thus secured was melted without any mixture of pig, a very desirable grade of iron was obtained. Still we find facilities for accomplishing this in very limited use. Refuse from all other departments should receive the same close attention. The use, or rather the abuse, of supplies is often the source of considerable leakage. In fact, leaks are likely to occur anywhere along the line, both in material and labor and the best way to guard against them is to know where to look for them.

As an evidence of what can be accomplished in this direction I may cite a case in a factory with which I was recently connected. In the first department to receive attention on the lines indicated in the foregoing, after a very slight effort, and that under unfavorable circumstances, a reduction in the labor cost of the product amounting to nearly 18 per cent. was realized, without any diminution in the average

earnings of the help, but rather an increase. This was in a department which was considered modern in most respects, and as it employed several hundred men, largely mechanics earning good wages, it can be seen what such a saving amounted to in a year. All other departments were treated in the same manner and a saving realized according to the condition in which they were found. The means by which the minimum cost of production can be reached are numerous and depend largely, of course, on the line of manufacture in which one is engaged; but perfect system and organization backed by good executive ability are absolutely necessary. When the employer has got his business so arranged that all sources of profit or loss are under perfect control, he will be in a position to decide whether he can afford to grant a demand for an increase of wages, or must ask for a reduction. The chances are, however, that when his business is in that condition it will not be necessary to ask for a reduction in order to meet competition, excepting during periods of extreme industrial depression. In order to avoid the necessity of a reduction, the workman should not murmur if he is requested to produce a good day's work in order to insure a good day's pay. He must remember that he is no more entitled to extraordinary remuneration than his employer is to extraordinary profits, and his co-operation is necessary to the realization of both. If he follows the inclination of his union to measure his service by European standards, he must be prepared to accept European conditions; for he can no more expect an American day's pay for a European day's work than his employer can expect an American day's work for a European day's pay—and in order to insure that advantage to his employer by which he can accord him that substantial recognition to which his record and achievements entitles him he must, in the language of the shops, "toe the mark" in line and harmony with his employer.



THE VALUE OF THE CAPACITY TEST IN BOILER-PLANT OPERATION.

By George K. Hooper.

Mr. Hooper's paper is a very interesting extension of the policy of intensified production into steam-making practice. It has direct analogy to many of the methods of works management often and ably advocated in this Magazine—methods whose purpose is to get the largest return in the shortest time per unit of investment—considering the relation of total output to total expenditure, and not economy of a single element in the scheme of production. It may be excellent economy to pay high wages for skilful workmen; it may be wise policy to drive a machine under high pressure to early destruction, for the sake of rapid production during its life; it may be, and Mr. Hooper shows that it often is, good practice in the boiler room to ignore economy per unit of fuel for the sake of securing higher economy per unit of plant. The subject affords opportunity for careful and profitable study.—THE EDITORS.

IT has been the custom for many years, in making tests of individual boilers or of completed boiler plants, to divide the subject in hand into two parts and to make one trial to determine what fuel economy can be obtained from any given installation, and one to determine what capacity the plant is capable of developing. These are known commonly as the economy and capacity trials respectively.

To the economy test is generally given the place of greatest importance, it being felt that, since the fuel bill is so great a part of the cost of steam production, the production of steam at the least expenditure for fuel is the prime requisite of a steam generator. While within certain limits this is true, its logical conclusion is that a form of generator calculated only to this end is such a device as no manufacturer would buy nor any engineer recommend for the every-day operation of a plant.

The construction and design of steam generators, as known to us today, has varied little in the past twenty-five years so far as concerns the ability to transform the energy stored in fuel into that contained in steam at any given pressure; the tests of the generators exhibited at the centennial of 1876 compare most favorably with those of today, even if any improvement can be noticed; but on account of the demands for higher and higher pressures, the advent of new and better materials of construction, and the natural evolution of the structure,

we have today in the steam generator of commercial use a structure of far greater capacity than has ever before existed. This is not necessarily because it is capable of producing a greater output per square foot of heating surface than the older types, but because it is capable of maintaining such greater output over a longer period of time with no increased risk to life and property nor unusual and unreasonable expense for maintenance.

If we can accept the above as containing even a germ of truth, it follows that the value of this capacity is worth a careful investigation, and a few examples are herewith given with a view of showing that such investigation is not unproductive of results of great value to the boiler user and interest to the boiler maker, even if they do not altogether reverse the importance which is now given to the two characteristics above mentioned and put in the place of first importance the capacity test, relegating the economy or fuel-efficiency test to the place of a curiosity only, and one to which we need pay no considerable attention.

There enters the discussion at this point a chance for an honest difference of opinion, since an able engineer of large experience has told us that he has found that the fuel efficiency of steam generators increases with their capacity, and considerable weight attaches to his results. It is a generally accepted fact, however, that his experience, although perhaps none the less actual, possessed certain unique features, since from time out of mind the capacity tests of such apparatus have shown a decreased fuel efficiency and higher evaporative rate than the apparatus exhibited at the point at which the maximum evaporation per unit of fuel had been developed. It is my opinion that the burden of evidence lies with the latter state of affairs, although I am prepared to accept the former within certain limits.

To the steam user, the various items which go to make up the cost of the steam produced in his plant are as follows: cost of fuel, cost of labor, rent or first cost of land, cost of buildings, draft, water, and superintendence, and all of the above possess a definite value. This value varies according to locations and ideas, but is always present and must be reckoned with. That the values may not be comparable between two given plants is very likely true, but that that fact has little bearing on the ultimate truth of the discussion is also true; it is necessary only to remember that they are present in some form and are straws showing which way the wind blows.

The fixed charges on the investments represented in the following examples will therefore be figured at 10 per cent. per annum for

interest on the money invested and at 10 per cent. per annum for the book depreciation.

The first example is that of a boiler plant in the middle western States using natural draft and being hand fired. The generators are in two units, and contain 3,750 square feet of heating surface each, the plant installed complete representing an investment of $15,558.20. The fuel is of a rather low grade and cost $1.31 per short ton in front of the boilers, while stokers' labor is worth $1.65 per 10-hour day per man. The cost of the fuel used includes the amount necessary for banking at night. The tests cover a period of ten hours each under actual running conditions, and the highest fuel efficiency developed was 68 per cent., which corresponds to an evaporation of 7.882 pounds of water from and at 212° F. per pound of dry coal. The generators under this condition evaporated 3.23 pounds of water per square foot of heating surface per hour from and at 212° F., making the cost of 1,000 pounds of steam the following:—Fixed charges per day, $10.04; amount of steam produced, $7{,}500 \times 3.23 \times 10 = 242{,}250$ pounds; coal used $(242{,}250 \div 7.882 + 2{,}310$ pounds for banking $=$ 30,734.6 pounds, which at $1.31 per ton represents $21.65. There were two stokers required to handle this fuel, which makes a labor cost of $3.30, while to bring the necessary feed water to the generators cost $1.20. The schedule is as follows:

Fixed charges	$10.04
Fuel	21.65
Labor	3.30
Water	1.20
Total	$36.19

and since 242,250 pounds of steam were produced, the cost to produce 1,000 pounds is obviously $\$36.19 \div (242{,}250 \div 1{,}000) = 14.939$ cents.

In the second instance the same plant was operated at an evaporative rate of 4.206 pounds of water per square foot of heating surface per hour from and at 212° F., an increase of 30.21 + per cent. over the first instance, the evaporation per pound of dry fuel dropping to 7.333 pounds water from and at 212° F., which corresponds to a fuel efficiency of 63.27 per cent., or 4.73 per cent. less than before. At this rate the plant produced $7{,}500 \times 4.206 \times 10 =$ 315,450 pounds of steam, consuming in doing so $(315{,}450 \div 7.333) +$ 2,310 pounds banking fuel $=$ 45,326 pounds of fuel, representing at $1.31 per ton a value of $29.69. The labor of two firemen was required in handling this fuel, giving a labor cost of $3.30 as before.

To bring the increased amount of water to the plant involved a cost of $1.56. The schedule is as follows:

Fixed charges	$10.04
Fuel	29.69
Labor	3.30
Water	1.56
Total	$44.59

and since 315,540 pounds steam were produced, the cost per 1,000 pounds is obviously $44.59 ÷ (315,450 ÷ 1,000) = 14.132 cents, or but 94.59 + per cent. of our cost at point of highest fuel efficiency, the output, it will be remembered, being 30.21 + per cent. greater.

In the third instance the same plant evaporated 5.33 pounds of water per square foot of heating surface per hour, or an increase of 65.01 + per cent. over the capacity at point of highest fuel efficiency, the evaporation per pound of dry fuel dropping to 7.21 pounds of water from and at 212° F., which corresponds to a fuel efficiency of 62.21 per cent., this being 5.79 per cent. less than the highest found. At this rate the plant produced 7,500 × 5.33 × 10 = 399,750 pounds steam, consuming in so doing (399,750 ÷ 7.21) + 2,310 pounds banking fuel = 57,753 pounds, which represents at $1.31 per ton a value of $37.83. An extra fireman was required in the handling of this greater amount of fuel, increasing the labor cost by 50 per cent., without, however, any disastrous results on the ultimate cost as the following schedule will show, an increased expense for water being also entailed:

Fixed charges	$10.04
Fuel	37.83
Labor	4.95
Water	1.98
Total	$54.80

and since 399,750 pounds steam was produced, the cost per 1,000 pounds is obviously $54.80 ÷ (399,750 ÷ 1,000) = 13.709 cents which is but 91.77 per cent. of the cost at point of maximum fuel efficiency, although the output is 65.01 per cent. greater.

The second case will deal with a plant under widely different conditions as to cost of fuel and labor. It is located on the sea coast, and consists of vertical fire-tubular boilers set in considerably larger battery, although each unit is small, containing but 2,500 square feet of heating surface. Since but one boiler was tested the results will be calculated for but one boiler. The plant is hand-fired at a cost of $2 per day per stoker, and the draft was furnished by a chimney, hence known as "natural." Fuel was worth $3.60 per ton in front of the boil-

ers. The cost represented by one unit of the plant in operating condition is $5,786.20, which gives a daily fixed charge on the basis explained above of $3.73.

Out of a considerable number of tests, that representing maximum fuel efficiency shows an evaporative rate of 2.48 pounds of water per square foot of heating surface per hour from and at 212° F., the evaporation per pound of dry fuel under the same temperature conditions being 11.09 pounds. This corresponds to a fuel efficiency of about 71.42 per cent., the indecision arising from the fact that no fuel analysis was given of the fuel so that an average of heat values from reputable calorimeter tests was adopted as a basis. The amount of steam produced was $2,500 \times 2.48 \times 10 = 62,000$ pounds, in the production of which was consumed $(62,000 \div 11.09) + 662$ pounds banking fuel $= 6252.6$ pounds, representing a value at $3.60 per short ton of $11.26. The labor of one stoker was used in handling this fuel, involving an expense of $2 for labor, although it is clear that the proportion of labor is very high. No expense was involved in bringing water to the plant. The schedule is as follows,—

Fixed charges	$ 3.73
Fuel	11.26
Labor	2.00
Total	$16.99

making the cost per 1,000 pounds of steam $16.99 \div (62,000 \div 1,000) = 27.403$ cents.

The second instance under this case shows the maximum capacity reached at an evaporation of 4.9 pounds of water per square foot of heating surface per hour from and at 212° F., the evaporation per pound of dry fuel dropping to 9.61 pounds of water under the same temperature conditions, which corresponds to a fuel efficiency of 61.88 + per cent., or 9.54 per cent. less than the maximum. Under these conditions the generator produced $2,500 \times 4.9 \times 10 = 122,500$ pounds of steam, at a consumption of $(122,500 \div 9.61) + 662$ pounds banking fuel $= 13,409$ pounds coal, representing a value at $3.60 per ton of $24.14. The schedule is as follows,—

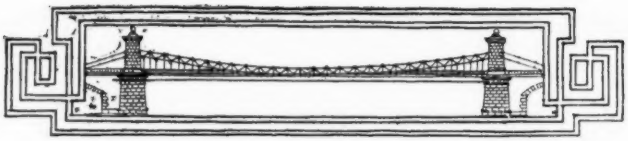
Fixed charges	$ 3.73
Fuel	24.14
Labor	2.00
Total	$29.87

There was no increase in the labor cost over the first instance, although the percentage of labor cost to the whole is yet higher than necessary. Since 122,500 pounds steam was produced, the cost per 1,000

pounds is obviously \$29.87 ÷ (122,500 ÷ 1,000) = 24.39 cents, which is but 89 per cent. of the cost at point of maximum fuel efficiency, although the quantity produced is 75 per cent. greater.

As a *résumé*:—The maximum capacity test in Case I. shows that it is possible in that plant to make steam for 91.77 per cent. of the cost at point of highest fuel efficiency, by increasing the evaporative rate and therefore the capacity of the plant to 165.01 per cent. of the capacity at that point, or to 153.16 per cent. of the commonly accepted rate on which the capacity of steam generators is founded; and in Case II that it is possible to make steam at but 89 per cent. of the cost at point of highest fuel efficiency, by increasing the evaporative rate and therefore the capacity to 175 per cent. of that rate at which maximum fuel efficiency is found, or to 140.8 + per cent. of the commonly accepted rate on which the capacity of steam generators is founded, even though the fuel consumption is increased by 9.3 per cent. in the first case and by 15.41 per cent. in the second.

At this point, without making this article cumbersome by giving the results of many other tests which have been figured over with similar results, I will rest my case in favor of the capacity trial. It has been made apparent that in not giving it careful study much opportunity for cheapening the cost of steam, whether for power or other uses, is neglected, since in the present use of steam generators, whether or not we consider the use of automatic furnaces, the limit of fuel efficiency has remained about the same for many years. That some of the present makes of steam generators are capable of maintaining high evaporative rates over an indefinite period is an indisputable fact, and the figures deduced above show that much more may be gained by changing design and construction to give increased strength and capacity than by cutting down first cost to maintain present maximum fuel efficiency. The field in this direction is no narrow one, since, if we accept the above figures as containing truth, a buyer will gladly pay 50 per cent. over present market rates for a generator to maintain such larger capacity, and one which shall at the same time cut down his operating costs by the percentages shown. It will be apparent to the thoughtful reader that the rate at which fixed charges are estimated may vary between wide limits without having appreciable effect on the result, the fact that such charges must always be present being of course an accepted one. It is also apparent that, should the fuel efficiency increase as the evaporative rate increases up to or beyond the points shown in the above examples, the case for the capacity test is made even more favorable.



THE AMERICAN LOCOMOTIVE AS A HIGH-SPEED MACHINE.

By Egbert P. Watson.

Mr. Watson's paper has especial value on account of the recent revival of interest in the working of American locomotives on British railways. The latter topic was ably discussed by Mr. Rous-Marten in THE ENGINEERING MAGAZINE for March last. Mr. Watson makes hardly any immediate reference to the controversy, but yet contributes valuably to its reasonable settlement by pointing out the fact that the whole problem is larger than can be encompassed in the measure of a few semi-experimental figures. The American locomotive does its work under conditions relatively much more difficult and trying than those imposed on the British engine, and does it well, from both mechanical and financial standpoints. The proof of its performance is in American railway rates and dividends. And Mr. Watson is in accord with the best American railway managers in maintaining that the proper place to begin the movement for faster running is not with the machine, but with the track over which it runs. —THE EDITORS.

ECKONING in round numbers, the distance from New York to Washington, D. C., is about two hundred and fifty miles; it is the same to Boston, Mass.; to New Haven it is seventy-two miles, and to Philadelphia ninety miles; but the average speed attained during the runs between these cities does not exceed forty miles per hour except upon a few special trains. In many cases the average speed is less than forty miles. An express leaves the Grand Central Station in New York City at 9:05 a. m. and arrives at New Haven two hours later, average speed thirty-six miles per hour, making but two stops in the run. The Pennsylvania Railroad and the Central Railroad of New Jersey run trains between New York and Philadelphia which require two hours to make the ninety miles, with but one stop scheduled, but with ferriage of ten to twelve minutes across the Hudson river included in the two hours' running

time; the Royal Blue Limited, of the Central Railroad of New Jersey, makes the run to Philadelphia in two hours and three minutes, and the run to Washington in five hours, schedule time, and these are the best trains in service, there being many others making more stops and having more coaches attached which are slower. The best and swiftest trains carry but few passengers, say two hundred and fifty when fully loaded, and it still requires a whole business day, twelve hours or more, to go from Boston to Washington, and this only when all connections are made promptly. There are, as is well known to travelers, several very fast special trains run upon some of the trunk lines—the fast express to Atlantic City, or the Empire State express which attains an average speed exceeding fifty-three miles per hour on a run of four hundred and thirty-nine miles from New York to Buffalo; but they run but once daily in each direction and cannot be said to be widely available to the general public, by reason of their limited accommodations.

The average speed on the railways of the United States is not markedly higher today than it was twenty-five years ago, between the principal cities of the Union, for at the period mentioned it required only six hours to go two hundred and fifty miles upon express trains, and that is the time required now. It is not asserted that the managers of railways are indifferent to this state of affairs, and do not desire to make better time; the contrary is true, and they have done what they could in certain directions to cut down the time between important terminals by straightening curves, reducing grades where possible, employing more powerful engines, and laying heavier rails, but the gains in time are slight in comparison with the public demand.

Careful consideration of the subject under discussion—higher speed upon railways—leads to the belief that it will not be attained for some years to come unless there is a radical change in the permanent way itself, and I am of opinion that therein is the chief obstacle. All the railways in the United States pass through the lines of least resistance, except where detours are purposely made to include certain districts where large amounts of profitable business can be had. The right-of-way in thickly settled portions is expensive, and if it is less costly to go three or more miles in an indirect line to avoid serious outlays or natural obstacles, the crooked route has in the vast majority of instances been laid out.

Now the earning capacity of a railway depends, all other things being equal, upon the hauling power of its locomotives under the

most favorable conditions, that is, upon the cost per train mile; and it follows as a corollary that when the conditions are unfavorable the railway suffers loss. For the purposes of comparison it does not matter in this consideration whether the immediate fault is in the rolling stock or in the line itself; the first can be remedied by procuring better cars, but the last postulate is a much more serious one. The topography of certain lines forbids high speeds; nevertheless fast running is attempted upon them, and there is a constant struggle, day by day, to endeavor to overcome natural obstacles by mechanical expedients, and the natural obstacles always win. Consider the case of a trunk-line railway following a tortuous water-way for long distances, directly upon the foreshore. Heavy trains, consisting of so many cars that the whole train is often upon reverse curves, are run at the highest speed possible, but with great loss of time and power, and this not for short distances, but for hundreds of miles on several different lines. It is not a matter for wonder that the average speed is low; it is astonishing that it is not less. For, while it is true that the locomotive of today is a far more powerful machine than it was twenty, or even ten, years ago, it must be borne in mind that the load and duty imposed upon the modern engine have been largely increased. This is one reason why the average speed is still less than forty miles per hour.

Some writers have urged the adoption of new types of locomotives with a view to obtain better service, but it would seem impossible, or if that is too strong a term, impracticable, to gain anything in this direction within any reasonable limit of time, for the simple reason that a radically new locomotive would be very slow in coming into practical use, and while it was being perfected and experimented with the traveling public would be no better off than it is at present. The locomotives in use on all the railways of the United States are of similar types in their several classes, such and such classes for speed and such others for hauling loads. They differ but in matter of details and proportions, and these moot points, so to call them, have been evolved only after long years of trial and error. If we are to throw all this experience away, and fly to other machines of which nothing is known, save that they "work" mechanically, or will apparently haul trains, we "take up arms against a sea of troubles" and for a certain period at least will fight losing battles. This is not a mere assertion or a prediction to sustain an argument; it is based upon the experiences of the past few years. The "new locomotive" projector is always with us, and it must be conceded

that he is a daring spirit generally possessed of the courage of his convictions.

Within ten years last past two "friction-geared" locomotives have been designed which were to settle the question of high speed affirmatively upon their first trials. It could not be shown to either of the inventors that his scheme was radically wrong in all directions, especially as regarded mechanical principles; they cared nothing for the latter, intending to overcome such difficulties by an "appliance"; nothing would satisfy them that the rest of the world were right and they were wrong except costly experiments, requiring full-size engines built upon their plans and put to actual use in hauling trains. This was done with results which had been predicted, but the inventors doubtless feel to this day that they did not have a fair chance. The two locomotives just mentioned came under the head of freak engines, for they were monstrosities in design and construction, unlike anything ever seen before upon railway lines, but still another new locomotive was built during the past decade which was intended to be a radical improvement over existing engines. It was planned by an engineer of ability, who conceived it to be his mission to solve the question of hauling heavy trains at high speed by certain modifications in the present locomotive. It was by no means a freak engine, but it contained several innovations which led to its rejection by railway officials. Among these departures was a corrugated, cylindrical, duplex fire-box, there being two furnaces joined like the letter Y, leading into a common combustion chamber. The junction of the branches of the Y with the combustion chamber gave constant trouble by leakage, and the valve-gear was also in dispute as to its reliability, it being a modified link-motion with the intention of securing better steam distribution. This locomotive was tried in various parts of the United States on different railway systems, but it was never adopted upon any of them, and certainly was not discarded from prejudice; it was simply tried upon its merits. Innovations are not themselves objected to, for they are constantly experimented with by railways all over the land; frequently they are designed by the officers of the motive-power departments and pronounced good, until, sooner or later, they develop weaknesses which render it impossible to maintain them and they are promptly thrown out, even after they have been put upon many engines.

The points of my argument as to the further development of the American locomotive as a high-speed and high-power machine are

these: That a radically new locomotive is not available for immediate service; that railway officials will give promising devices fair trials; and, lastly, that the field for radical improvement is exceedingly limited. Step by step the present engine has been raised from 500 horse power to 1,500 horse power and more in some cases, but not by means of startling novelties of any kind. The chief improvement has been secured through increasing the boiler power from 150 pounds per square inch, which was a maximum fifteen years ago, to 200 pounds as a rule and 225 pounds per square inch in some engines; but the steam-distributing details remain just where they were fifteen years ago, with some modifications in dimensions—none whatever in application. I believe that the cylindrical, corrugated fire-box, recently introduced by Mr. Cornelius Vanderbilt, has great possibilities in the direction of still higher pressures, and in that direction is an advance; but higher pressures alone will not increase average railway speed 20 per cent., and at least that increase is demanded.

The greatest stumbling block is the line itself, as it exists on most American railways between important terminals—the large cities—and it seems hopeless to expect any improvement until the roadbeds of the railways of the United States are constructed for high speed. There is no object in building higher-powered locomotives to drag trains up steep hills and around short curves, or upon gradients more or less heavy, by brute force. That is merely burning the candle at both ends, for it increases the expense of maintenance without correspondingly improving the service. High speed as obtained at present is costly—exceedingly so—and railway managers are well aware of it. The expense begins with the engine itself and its maintenance in and out of service. The American Railway Master Mechanics' Association recently appointed a commission to inquire into the details of cost and the replies to these inquiries are before me as I write. Briefly, these show that a modern high-speed locomotive costs from 25 per cent. to 50 per cent. more than one for ordinary speeds; the cost of fuel for high speed is from 15 per cent. to 20 per cent. greater than at ordinary speeds, while the cost of repairs is higher, but not stated in fixed terms. High speed, as understood by these investigators, means fifty to sixty miles an hour including stops. These are only the first items of extra cost, but all other and subsequent stops add to the increase of outlay, for the "great and gineral public," as Andrew Jackson called the people, seeing their fellows flying along the road, demand higher speed for their trains

too. The inevitable result of the putting on of a few fast trains is the general speeding up of the entire passenger-train service of the railway line.

While it is evident from the testimony adduced that running at sixty miles an hour is more expensive than at forty miles an hour, it is not at all certain that the railways could get any more from the public if they provided the higher speed.* In some States the rate per mile is fixed by law, so that would have to be traversed; but the disposition of the public everywhere to get something for nothing by all possible means would entail more or less tedious legislation. Increased compensation is now obtained upon some trains, but it is for certain accommodations or appointments in the coaches, never for rapid transit pure and simple.

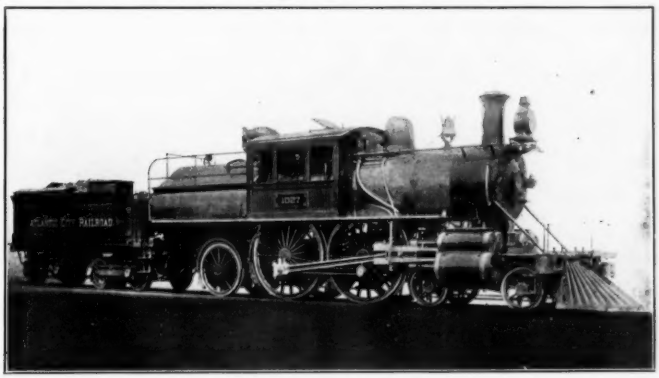
However this may be, there is nothing to prevent a high average speed with the present locomotives if the lines were constructed to permit it—that is, were they nearly straight and level instead of crooked and hilly—and confined to the specific object of high speed in lieu of general traffic. The usual course of a fast train is to start upon a schedule provided for it and make certain points at certain times. This could be done easily enough if there were no other trains in operation and no other events transpiring at the same time outside of the railway's affairs; but this is, of course, impossible, and the driver of a fast train is frequently held up several times when he has no reason to expect it by the exigencies of the traffic. In other words, he loses time from the start from causes beyond his control, and has to recover it by running faster thereafter. Where the road is fairly level and the grades light, there is no difficulty in very much exceeding the schedule; but it usually happens that exactly the reverse obtains and the old copy-book maxim—"Time lost is never regained"—comes true.

Suppose a railway line upon a causeway, elevated where necessary to clear natural or artificial obstacles, having curves of very long radii were demanded, but following an air-line generally between

* As Mr. Rous-Marten pointed out clearly in his able article on "The Question of Cost of High-Speed Trains" in THE ENGINEERING MAGAZINE for February, 1901, the inducement to the railway is the increased travel and augmented passenger receipts which certainly and promptly follow every reduction of running time. Facilities create traffic, beyond any possibility of estimation in advance. Increased passenger mileage would justify an increase of cost per train mile; but Mr Watson argues soundly that the proper way to better American railway speed is by improvement of the permanent way, making it possible to run faster or pull heavier loads without increasing the cost per train mile. This has been the salient feature of the best American railway management as developed on the Lake Shore, the Pennsylvania, and others of the greatest and most successful railways in the United States.—THE EDITORS

New York and Philadelphia, where the sea-level is practically the same. Upon such a causeway there would be no difficulty whatever in reducing the time to eighty minutes, in lieu of the present one hundred and twenty minutes as the best time; there would be no difficulty in reaching New Haven in sixty minutes, instead of twice that time, and real rapid transit would be inaugurated, attended with perfect safety. One objection to such a line would be the first cost and maintenance, but neither of these objections is insuperable. A railway of very much this character is, in fact, now in course of construction under New York city, where the difficulties and consequently the cost are greatly enhanced from its subterranean position, and the contract calls for $34,000,000 for thirty-four miles, or $1,000,000 per mile. No elevated structure could be made to cost anything like that sum, and travel on it would be far safer than upon the surface of the earth. The first law of motion is that "a body in motion moves in a straight line with *uniform velocity* unless acted upon by some external force," and as there would be no external forces upon an elevated railway there would be no opposition to exceedingly high speed. In view of this proposition, or coincident with it, the expense of repairs to the locomotives would be rather less than at present, from the fact that the resistances are less, there would be a total absence of dust, and a uniform load from start to finish. This last feature is one of very great importance in transporting merchandise economically by steam power, and would open possibilities for compound locomotives which they have never yet enjoyed to show what they are capable of. It is well-known to experienced railway men that the race ground of any line is a level stretch of some length, and that the modern American locomotive with anything like a reasonable load behind it (and sometimes an unreasonable one) is capable of tremendous sustained velocities even with a dirty fire and by no means picked coal; given Pocahontas, or any other approved fuel, which burns and leaves the grates clean, a clear track and no hold ups, with a driver who is not afraid to ride fast, and he would give the public all the fast running they wanted, day in, day out, with the present engine. There is no occasion for either eulogizing or disparaging its abilities, it is simply a magnificent machine, and he must be unimpressible indeed who can stand beside a track when Apollyon goes raging by with ten or twelve coaches at sixty-five miles an hour, under the stress of a 200-pound whip laid upon his shoulders by a calm-eyed little man in the cab!

The comparative performances of American locomotives and those of other makes are not to be established in a magazine article, or, for the matter of that, in any article. Disquisitions and assertions are worthless in the face of train-sheets; they are the only arbiters, and time and again American locomotives have been compared with foreign locomotives and have shown themselves first in the rank of railway machines in all that is essential. Pound for pound, both in the load drawn and steam carried, over the same route, equal skill in driving being assumed in both cases, is the only test which can be made of two engines by different makers, as regards their capacities. The private or public opinions of more-or-less disinterested parties upon either side have nothing to do with the issue.



TYPE OF ENGINE MAKING THE FASTEST START-TO-STOP RUN IN AMERICA—55½ MILES IN 50 MINUTES ON THE ATLANTIC CITY FLYER.

The enormous mileage of successfully operated railway in the United States, much of it through thinly settled districts where the traffic has only a fraction of the density found in Britain or on the Continent; the comparative cheapness of American railway freight rates—stated by Mr. Phillips in THE ENGINEERING MAGAZINE for May to be only about one-sixth of what they are in Britain, while first-class American passenger fares are barely equal to third-class English fares; the phenomenal performances in transport also described by Mr. Phillips in his study of ore movement in the United States—all these afford so substantial proofs of the efficiency and relative economy of American railway motive power that no other answer need be made to critics of the American engine.

Locomotives which can contribute to such results, when working

over roads which are in the main far inferior to the average British standard, show by their own record the imperfect information or the prejudice of those who would cry them down as "costly failures" and "worthless at any price." As to the results lately given out in Great Britain, it is sufficient to quote Mr. Rous-Marten's comment in THE ENGINEERING MAGAZINE for February last:

"But there is, of course, another side to the present question. It is quite certain that the American engines have laboured from the outset under one most serious disadvantage, wholly apart from that attaching to the insular prejudice of drivers and foremen. And this consists in the fact that they are not the sort of engines that American engineers or builders would have designed for the class of work they are put to. I do not wish to be misunderstood. I am casting no reflections on either British or American designers. I simply say that they view the requirements of traffic from different standpoints, and that a British engineer, keeping in mind the precise local requirements of British goods traffic and the special features of British methods and materials of construction, would design for a given class of duty an engine totally different from the one which an American engineer, bearing in mind the precise local requirements of *American* freight traffic and the special features of *American* methods and materials of construction, would design under the like conditions. No one who knows anything of American ways will contend that, had every point excepting the extreme dimensions been left to the Baldwin and Schenectady companies respectively, those builders would have constructed for the specific duty the same type of locomotive as that which they turned out to the order of the British railway companies. As it was, they had to do the best they could under stringent conditions."

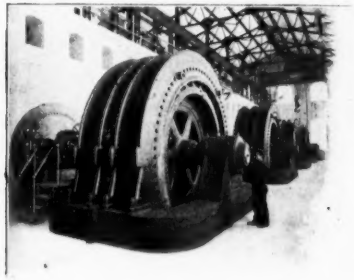
If an indictment is to be drawn in re Higher Speed *vs.* American Locomotives, the American railroads themselves must be made parties to it. When they mend their ways, there will be no cause of action.

THE GREAT ELECTRICAL INSTALLATIONS OF ITALY.

By Enrico Bignami.

THE WATER-POWER PLANT AT PADERNO D'ADDA, LOMBARDY.

The hydro-electric power installation is always a widely interesting study, as representing the effective union of the most skilful work of the civil, the mechanical, and the electrical engineer. It has a deeper significance in its bearing upon economy in utilising the natural resources of the earth. It should not be unexpected, therefore, to find that the rapid extension in the use of power which characterises this age should cause an early development of water-power resources in countries like Switzerland and Italy, which are poor in coal supplies. But how rapidly this development has gone out is suggested with almost surprising effect by the contemplation of the 22,000-horse-power installation at Chèvres, described by Prof. Prásil in our preceding issue, or the Paderno plant of nearly 15,000 horse power which Signor Bignami reviews below. The great Niagara station, though designed for far greater ultimate output, began with about the same power delivery and much shorter transmission. And the interest is intensified when it is noted that, with wise cosmopolitanism of engineering practice, this huge enterprise has been brought to striking success by drawing the best in the way of machinery, methods, or advice from all the great industrial countries.—THE EDITORS.



THE installation at Paderno d'Adda cannot be considered alone, as it forms part of a complex whole comprising under the general plan of a single undertaking all the public and private services of the Società Generale Italiana Edison di Elettricità in the city of Milan. The energy generated at Paderno is transmitted to Milan and received at the Porta Volta station, this being both a receiving and distributing substation and an independent steam-driven generating plant, in which the two power services are arranged for independent or joint supply to replace one another as may be required. From this station as a centre electrical energy is distributed for a large number of purposes. Part of it is received and transformed at the Santa Radegonda substation, whence it is delivered for traction purposes and for the feeding of lighting mains in the centre of the city. Another part of the main distribution goes to power and lighting customers in the industrial quarters of the city.

The Water-Power Plant at Paderno:—These water-power developments—dam, canal, tunnels, etc.—like all other similar engineering works, do not show in their finished condition the difficulties imposed by their design and execution. In this case the method employed in the work was as follows:

A few hundred metres below the famous bridge of Paderno there has been, for two centuries, the intake of the canal known as the Paderno canal, which was used to make a navigable waterway alongside of the rapids which here impede the passage of vessels at all stages of water. The intake consisted of a submerged dam and a

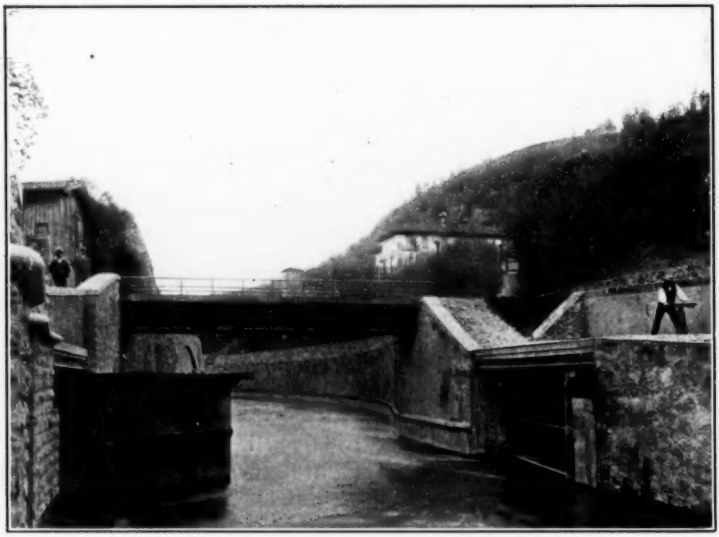
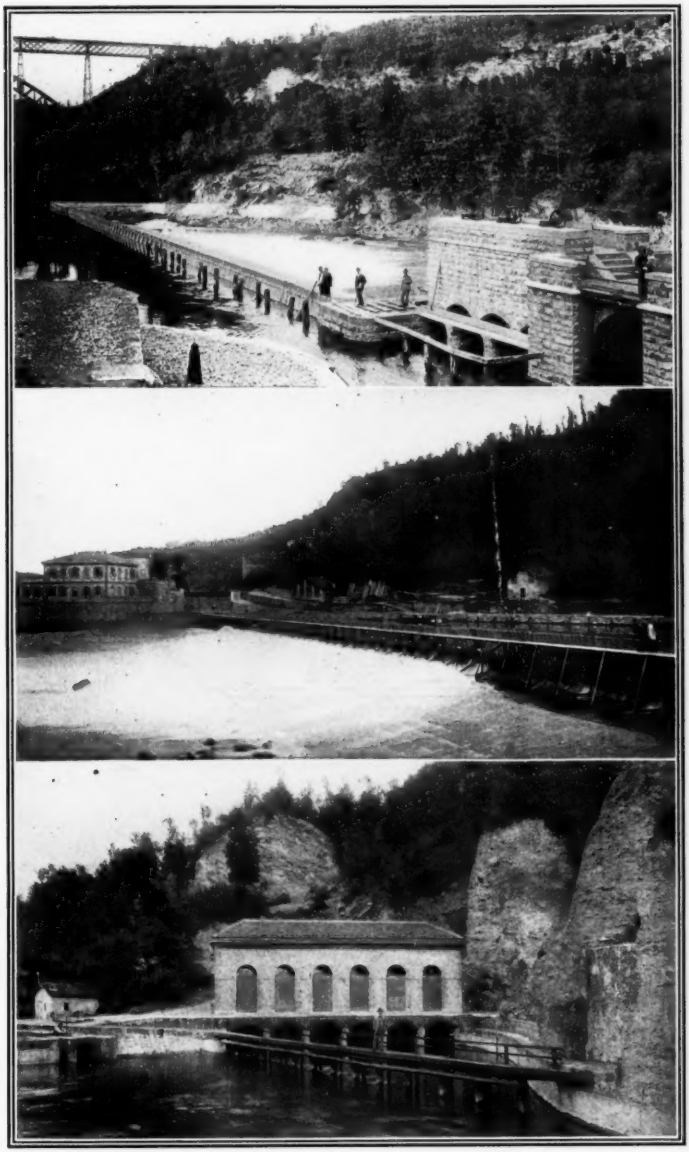


FIG. 1. ROTARY METALLIC SLUICE GATES AT THE HEAD OF THE SUPPLY CANAL.

pair of gates which regulated the admission of water to the canal. A happy idea seized upon these ancient works for the assistance of the new development; but neither the section of the canal nor the height of the dam was sufficient to handle the flow of 45 cubic metres of water per second required by the proposed electrical installation. The upper part of the dike was reconstructed and changed to a needle weir with movable collapsible frames (Figures 2 and 3) and the canal was widened from 9 to 13 metres, so that the velocity of flow in it is 1.37 metres (4.48 feet) per second, with a delivery of 45 cubic metres (1,588 cubic feet) per second. The widening extends for 690 metres



FIGS. 2, 3, AND 4. THE TWO UPPER VIEWS SHOW THE UPPER AND LOWER SIDES OF THE NEEDLE DAM ACROSS THE RIVER ADDA. THE LOWEST ONE IS THE GATE HOUSE AT THE HEAD OF THE SUPPLY CANAL.

(2,263 feet) from the head of the canal to the "Conchetta" where the first of the renowned seven basins is found.

At this point is the real head gate of the new canal, (Figure 4) built over six sluiceways, each furnished with hand-operated gates. A few yards further, the canal, leaving to the left the boat canal which traverses the smiling valley of the Adda, enters a tunnel 105 metres

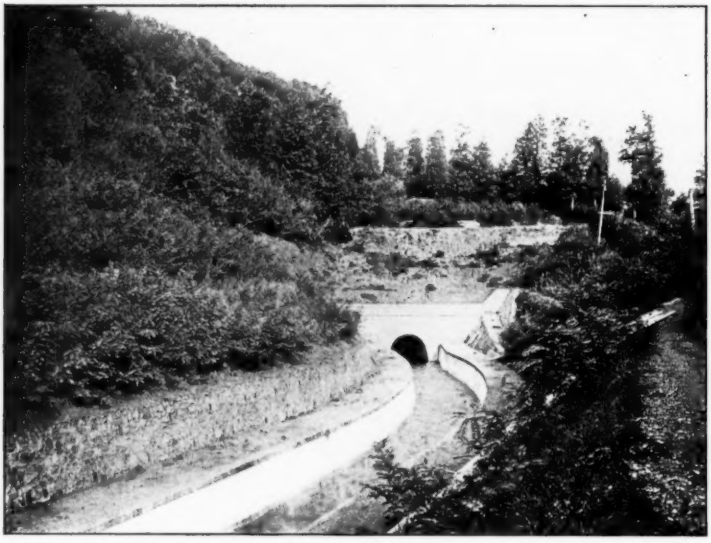


FIG. 5. MOUTH OF THE FIRST TUNNEL, AND PART OF THE CANAL IN EXCAVATION CUTTING.

(344 feet) along whence it flows out into an open cutting of a mean depth of 8 metres and 230 metres long; thence it passes through another tunnel 278 metres long, a second cutting of 352 metres, and then the last and longest of the tunnels, 1,005 meters (3,296 feet) long. The end of this tunnel is shown in Figure 6. The canal is, altogether, 2268 metres (7,449 feet) long with a cross-section of flow of 16.80 square metres (180.8 sq. feet) and delivering 45 cubic metres (1,588 cubic feet) per second under a velocity of flow of 2.70 metres (8.85 feet) per second. The last tunnel abuts at a point where the configuration of the valley is, so to speak, convenient for the situation of a water-power works. Here a large basin receives the water coming out of the tunnel and allows its velocity to fall, before it passes through the head gates of the steel penstocks, to about one metre per second. At the left of this basin is the crest of a great waste weir,

having an ultimate capacity for 52 cubic metres of water per second. The sluiceway is in the form of a gigantic flight of stone steps, 29 metres (95 feet) high and 30 metres wide. Over this the falling water breaks so that the great force of its fall is weakened and gradually destroyed. Figure 7 gives an excellent view of this fine artificial waterfall.

From the receiving basin, seven steel penstocks, each 6 ft. 11 inches in diameter and built of plates from 7/32 to 1/2 inch thick, lead to the turbines (Figure 8). These pipes rest upon the natural slope of the ground, their length being 205 feet. Each is provided with a gate at the top, while the flow to the turbine is controlled by a butterfly valve at the bottom. The tail water from the wheels goes first into a large basin, whence it is discharged, not directly into the river but into the boat canal. This is done to prevent interference with the navigation of the latter by too great withdrawal of water.

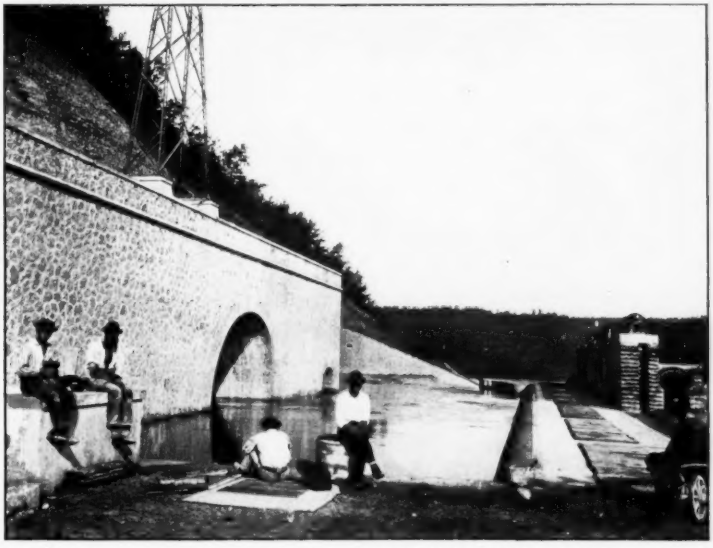


FIG. 6. OPENING OF THE THIRD TUNNEL. BASIN AND HEAD OF PENSTOCKS TO THE TURBINES.

At low water the net fall, with 45 cubic metres flowing in the canal, is 28.82 metres (94.5 feet); at times of freshet this is reduced to about 82 feet. To compensate for this decrease in head, all the work—canals, tunnels, wheels, etc.—was designed for an increased flow of 52.25 cubic metres, this amount being needed to maintain the

FIG. 7. STEPPED SPILLWAY FROM THE BASIN ABOVE THE TURBINES.

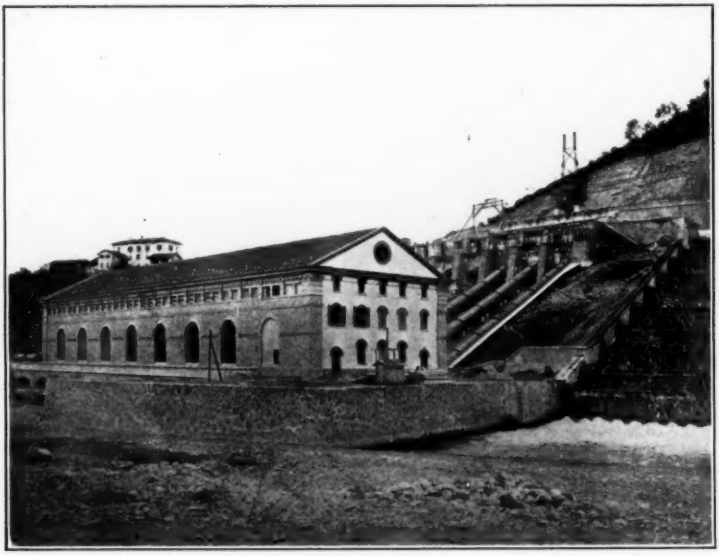


FIG. 8. THE PADERNO HYDRO-ELECTRIC STATION, SHOWING THE PENSTOCKS AND THE SUPPLY BASIN ABOVE.

same output with the lower head. The power theoretically available from this head and volume is 17,300 horse power, or, allowing 75 per cent. efficiency in the turbines, an actual delivery to the dynamo shafts of 13,000 horse power.

Turbines and Accessory Apparatus:—The power-station building, which is 61 metres (200 feet) long, 20.4 metres (67 feet) wide, and 10.95 metres (36 feet) high to the spring of the roof, is almost entirely occupied by the main machinery room. Its north wing is used for storage and for the lodgings of some of the working force of the station.

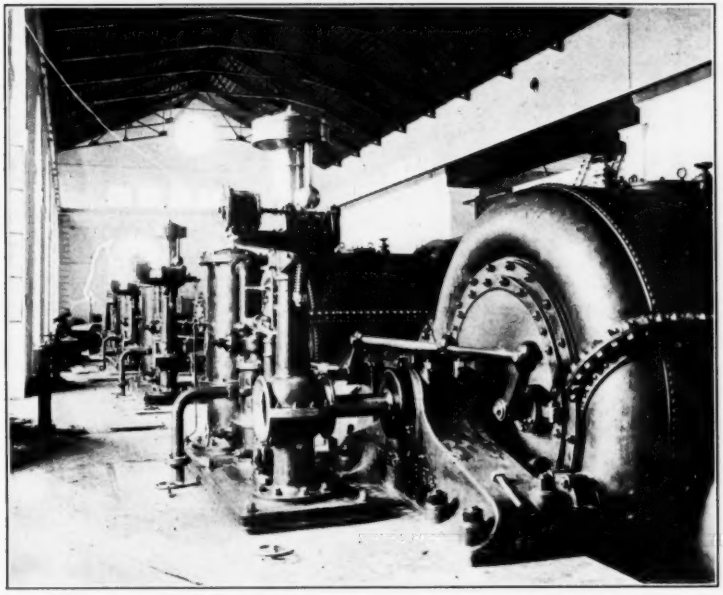


FIG. 9. PADERNO HYDRO-ELECTRIC STATION. THE TURBINE GOVERNORS.

In the main dynamo room there are now installed six units, each of 2,160 horse power; the complete installation will comprise seven. Each is composed of one horizontal-shaft turbine direct-coupled to one alternator through an adjustable Zodel coupling (Figure 9). These were the first turbines of more than 2,000 horse power built in Europe, and the credit of their success belongs to Italy. The house of Riva, Monneret & Co. built the wheels, which both in output and operation successfully met the requirements of specifications and guarantees.

The turbines are of the horizontal-shaft pattern, with inwardly

directed admission and axial discharge. The runner is of American type, with multiple curves of which the form was established after numerous experiments rather than as a result of calculation. Normal speed of these units is 180 revolutions per minute. Their governors are of the Ganz type, slightly modified to meet the requirements of this particular installation.

Dynamos and Accessories:—The dynamos, as well as all the other electrical apparatus, were built by Brown, Boveri & Co. of

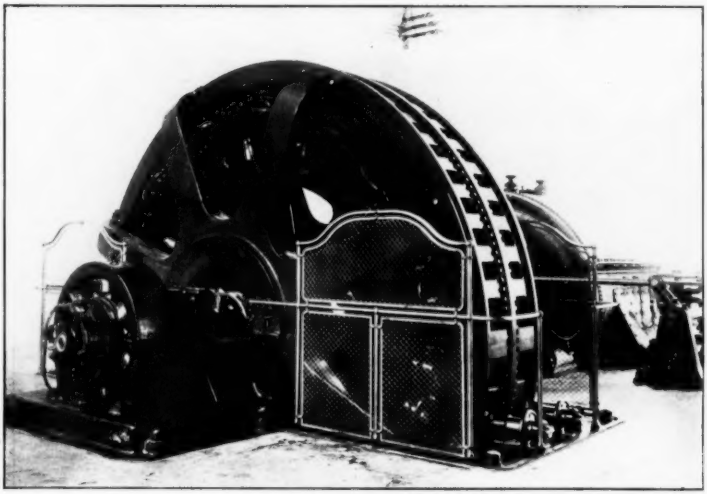


FIG. 10. PADERNO GENERATING STATION. TURBO-ALTERNATOR OF 2,160 HORSE POWER AT 13,500 TO 15,000 VOLTS.

Baden, Switzerland. Among the various engineering firms bidding on the work this concern was the only one that presented a completely worked-out design—one that was a little hazardous, perhaps, for its time. They proposed feeding the transmission line at 13,500 volts generated directly upon the dynamos without transformation. I call this hazardous because, in 1895 and in Italy, installations at higher pressures than 6,000 volts were unknown. This, too, was the first time that dynamos of 2,000 horse power and 15,000 volts had been constructed. The machines are truly admirable from all points of view, and their success marked a new step in the use of high electrical pressures. In Figure 10 one of these machines is shown. Paralleling these generators has never given any trouble. They can be coupled even when running light, showing that the turbine governors work ad-

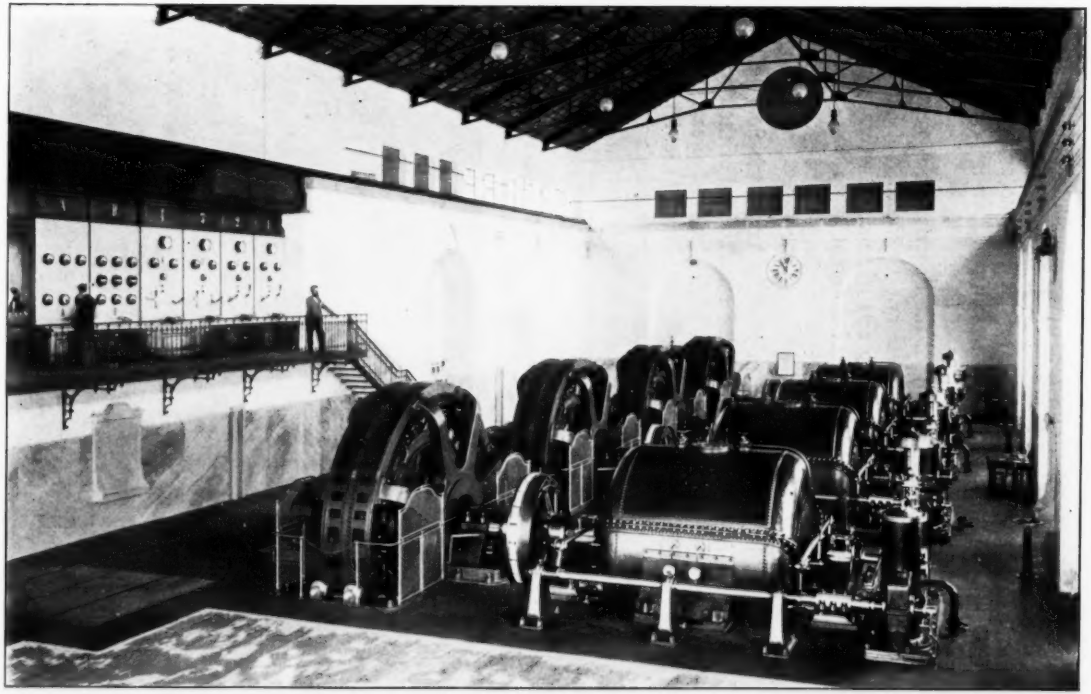


FIG. 11. TURBINE AND GENERATOR ROOM, PADERNO GENERATING STATION.

mirably. The load is divided among the machines by means of small auxiliary motors working on the governor gates and controlled from the switchboard, shown in Figure 12. It is interesting to note, also, that parallel operation of the alternators at Paderno and the steam-driven machines in the Porta Volta station at Milan is very easy of accomplishment.

Frequently, during the building of the Paderno plant, recourse to these Milan machines has been necessary. Connecting in has never presented any difficulty and the two sets of machines, twenty miles apart and driven by prime movers of different types, have worked together as well as if they had been installed alongside of each other in the same station.

The dynamo leads are carried in conduits under the floor to the switchboard, the front of which is on the western wall of the dynamo room. In an installation where such high electrical pressures are handled the switchboard is an element of prime importance, for upon it the current is governed and handled and with its simple levers and handles is controlled the immense power invisibly transmitted by the wires. This main switchboard was built with great care and occupies altogether a space of 160 square metres.

In planning this delicate and important part of the station the engineers of the company and the builders made use of the experience

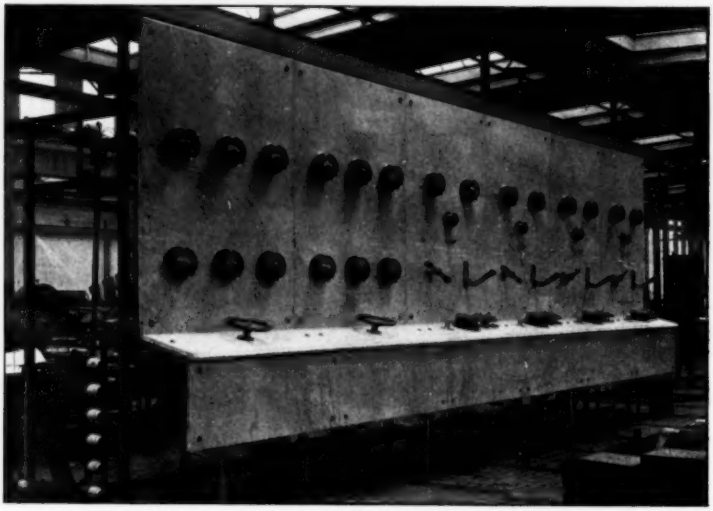


FIG. 12. SWITCHBOARD FOR MEASURING INSTRUMENTS.

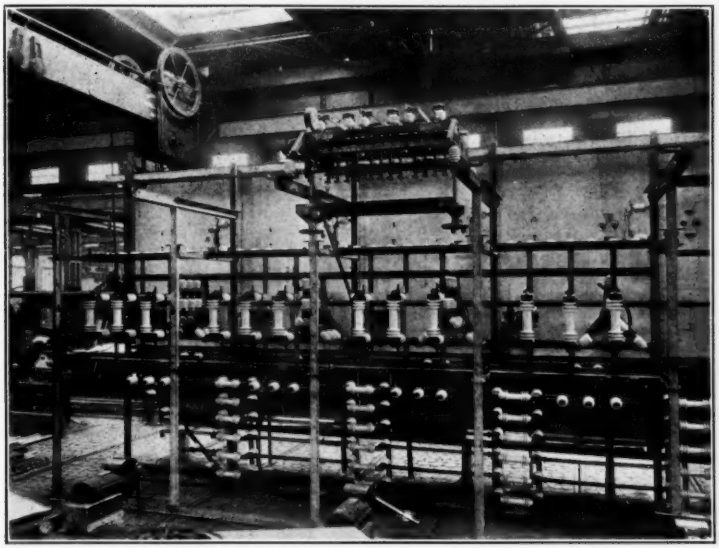


FIG. 13. SWITCHBOARD WITH CIRCUIT BREAKERS.

gathered in the working of the 3,600-volt installation at Milan, and, aside from some points of which mention is made below, this experience was not without advantageous outcome. The most important parts of the switchboard are the circuit breakers and fuses. The circuit breakers have been very successful, making a swift break under oil and permitting a current of 100 amperes at 15,000 volts to be broken without trouble or the appearance of more than a small spark in the oil. Fuses, however, have not given such entire satisfaction. The type employed is a tube, open at both ends, in which is stretched a lead wire. (Figure 13.) While the working of the fuses has not always been perfect, I should say here that accidents on their account have been less frequent on the 15,000-volt line than upon the distribution circuits working at 3,600 volts.

The Transmission Line:—Many of the problems presented by the transmission line were novel and without precedent, at least in Italy; especially so were the phenomena of self-induction which had caused much trouble in former undertakings. The line is, naturally, that part of the installation most liable to exhibit trouble, particularly when it is worked at very high tension, and is exposed to the accidents of weather and the risk of malicious interference. The transmission line

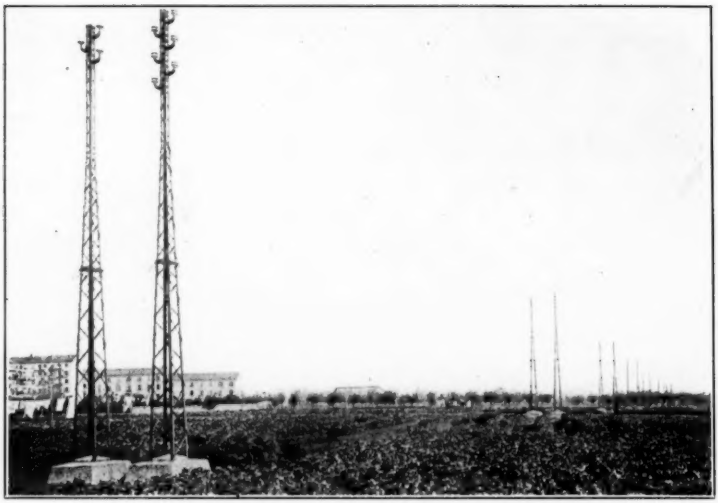


FIG. 14. PADERNO-MILAN TRANSMISSION LINE, SHOWING ORDINARY TYPE OF POLES.

from Paderno to Milan is carried on strong and handsome structural iron poles, built by the Savigliano shops (Figure 14). They are set in pairs, two metres apart, with an interval of 60 metres (197 feet) between pairs. The pole tops are 33 feet high above the ground, and each pole is capable of carrying 9 copper wires of 9 millimetres diameter (about No. 00, B. & S. gauge). By this double arrangement of the line, which consists practically of two lines parallel with one another, repairs or alterations are easily effected, one side carrying the whole load while work is in progress on the other.

Some curious fears and doubts were expressed when it was decided to use metallic poles on this line. It was said that it would be dangerous to touch the poles; that the presence of these conducting bodies in the magnetic field surrounding the live wires would augment the self-induction of the circuit and increase the energy losses. On the other hand, a comparison of the depreciation costs of wood and iron poles shows a difference in favour of the wooden poles, more than offset, however, by the advantages of the iron supports. These are greater safety and strength, with a consequent reduction of the number of poles necessary, carrying with it an equivalent reduction in the number of insulators and thus combining economy with a lessening of the number of points of weakness in the line.

Practice has demonstrated that danger to persons touching the

poles is absolutely without existence, and that the alarm felt on other grounds was equally without foundation. The line as constructed is very stable and is one of the most handsome in existence. During the year 1900 there were twelve storms. Service interruptions due to storms, since the commencement of operations in 1898, have been only four in number so far, and of these two are attributable to bad working of the lightning arresters, which held an arc. After the two instances referred to, which occurred in 1899, the number of air gaps in series with each Wurts lightning arrester was increased from 42 to 54, since which there has been no further inconvenience.

It is remarkable that upon this line, traversing a region almost wholly without trees of high growth, in which storms are very violent, and where hail is the cause of frequent devastations, the number of discharges of the lightning arresters has been very small. It is rare for more than four or five discharges to take place during a storm. Does this fact depend on local conditions, or do the iron poles play a protecting *rôle?* Is it not, perhaps, due to a continuous slow discharge of the line by the arresters preventing the accumulation of large electrostatic charges?

Upon the same poles with the transmission wires are carried the Paderno-Milan telephone lines. Concerning the working of the telephone I can do no better than quote Signor Guido Semenza, one of the

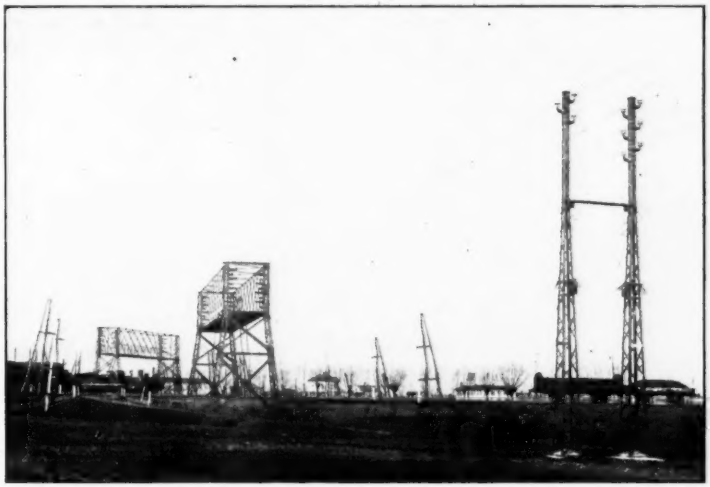


FIG. 15. TRANSMISSION LINE, SHOWING BRIDGE ARRANGEMENTS FOR CROSSING THE LINE OF THE MILAN-VIGEVANO RAILWAY.

engineers and a director of the Edison Company. His report of the matter is as follows:

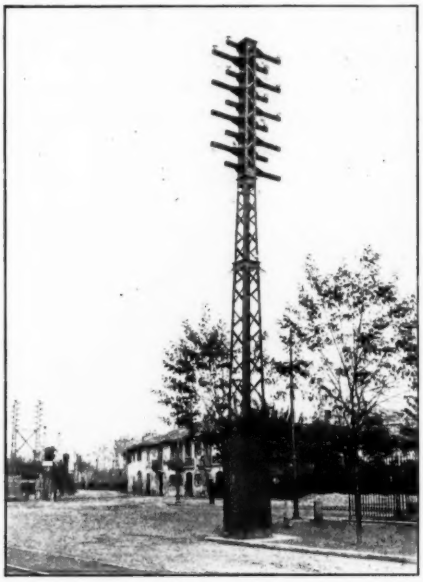


FIG. 16. TRANSMISSION LINE SPECIAL POLE AT THE ENTRANCE TO MILAN.

"Considerations of economy and convenience of inspection frequently lead to the erection of the telephone line on the same poles with the transmission wires. At the outset of our exploitation we concluded that induction would cause such noises in this case as to disturb or even forbid telephone communication. The remedy, however, is very easy to apply when the true causes of the disturbance are understood.

"I feel justified in saying that the noises disturbing the telephone are caused by electrostatic induction. Electromagnetic induction, in our case, at least, gives no trouble. Our telephone circuits are not transposed or spiraled. Nothing has been done to counteract electromagnetic induction, nevertheless the noise has been almost entirely suppressed by very carefully insulating all parts of the telephone circuits from the ground."

On curves in the line and at angles, as well as at the point where the line enters Milan, a special form of pole is used. (Figure 16.) At the three crossings of the line over railways, at Sesto, Monza, and Milan, veritable iron bridges were erected to meet the requirements of the railway companies. Crossing at right angles only is attempted. (Figure 15, page 711).

A serious element of difficulty was found in the insulators for iron-pole line work. Two types were adopted, one being used on one of the parallel elements of the transmission line and the other on the other element. The first is of American design, known as the "helmet type"; the other, having four conical petticoats, was produced by the house of Richard-Ginori at Milan, each insulator being tested to 45,000 volts.

The course of the transmission line does not follow the roads but

is almost straight. It measures altogether 32,785 metres (24 miles). The company owns the right of way along the line for a strip three metres wide. On the heights near Monza the line branches and a circuit is taken off to feed a manufacturing village in that neighbourhood. The line goes into the city of Milan, turning to avoid the Monumental Cemetery, and ends at the Porta Volta station, where it is dead-ended upon two solid structural-iron poles (Figure 17). A series of Wurts lightning arresters protects the line at this point and the conductors are carried into a special switchboard, passing thence to the transformers.

The Porta Volta Station:—The bank of transformers for reducing the line tension to 3,600 volts is placed on an intermediate floor of the station in a room by itself. The switchboard controlling them is placed in a room immediately above the transformers. At present the transformers, which were made by Ganz & Company, of Budapest, number twenty-five and each is rated at 350 kilowatts. A blower installation operated by electric motors is used to furnish air for cooling these colossal pieces of machinery.

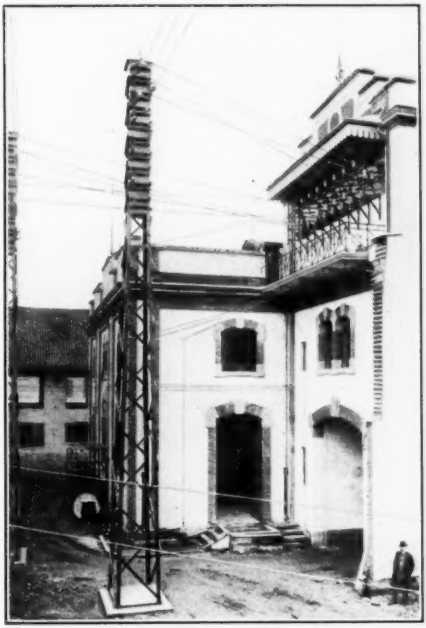


FIG. 17. PORTA VOLTA TERMINAL OF THE AERIAL TRANSMISSION LINE FROM PADERNO TO MILAN, SHOWING ANCHORAGE POLE.

The Porta Volta station—substation and independent generating plant at the same time—is, as mentioned above, the centre of distribution for Milan. So far as the station is concerned its sources of energy are twofold—the transformers, feeding into it, energy coming from Paderno, and dynamos coupled to steam engines in the station itself (Figures 18, 19, and 20). These two sources furnish energy under the same form—that is, three-phase currents at a

frequency of 42 cycles per second and under a tension, in the intermediate network, of 3,600 volts. It is possible, on account of this arrangement, to combine upon the switchboard at this station energy coming from the waterfalls at Paderno and that produced by burning coal in the building itself, so that the two independent sources of energy work together, or either one may be substituted for the other. At present a considerable enlargement of this station is under construction, a new steam-engine unit of 4,800 horse power. This unit will consist of a Brown steam turbine and a three-phase alternator, giving 3,600 volts and 42 cycles per second under a speed of 1,200 revolutions per minute.

Distribution Lines:—The distribution of electrical energy, of which the Porta Volta station is the centre, can be divided into two

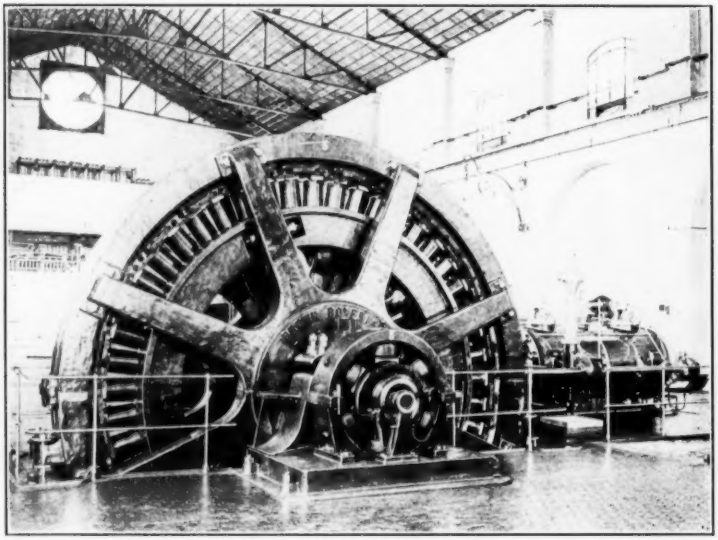


FIG. 18. GENERATING UNIT AT THE PORTA VOLTA STATION. ALTERNATOR DIRECT-CONNECTED TO 1,000-HORSE-POWER ENGINE.

kinds: that which is made directly by means of three-phase alternating current, and that which is made by direct current after transformation at the Santa Radegonda station (Figure 21). The three-phase distribution is made by means of seven underground cables working at 3,600 volts, distributed from the Porta Volta station. Two of these cables run semicircularly around the city in one direction, two others go in the opposite direction, the four being brought together at a

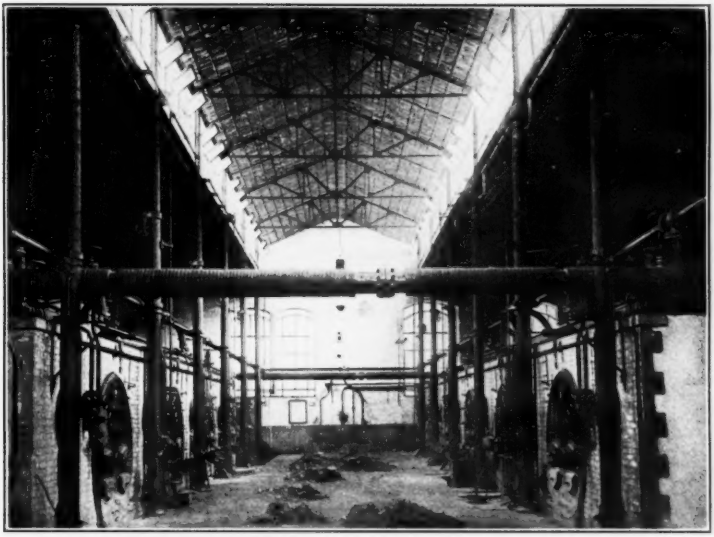


FIG. 19. BOILER ROOM, PORTA VOLTA GENERATING STATION.

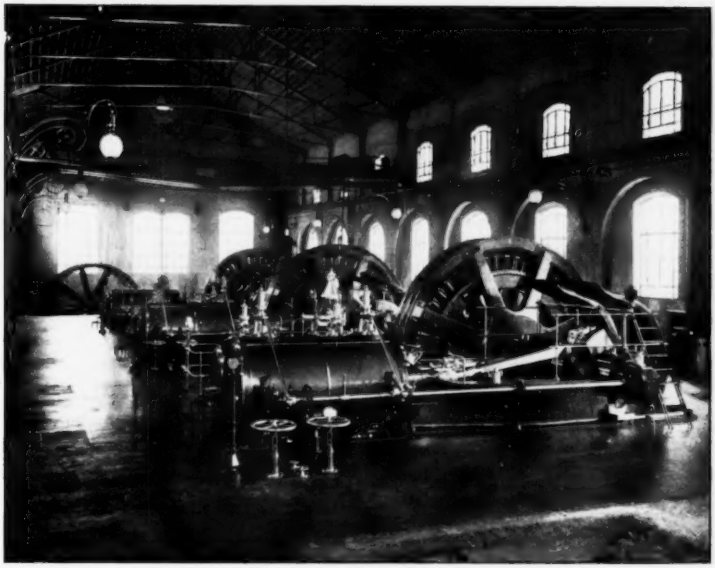


FIG. 20. ENGINE ROOM, PORTA VOLTA GENERATING STATION.

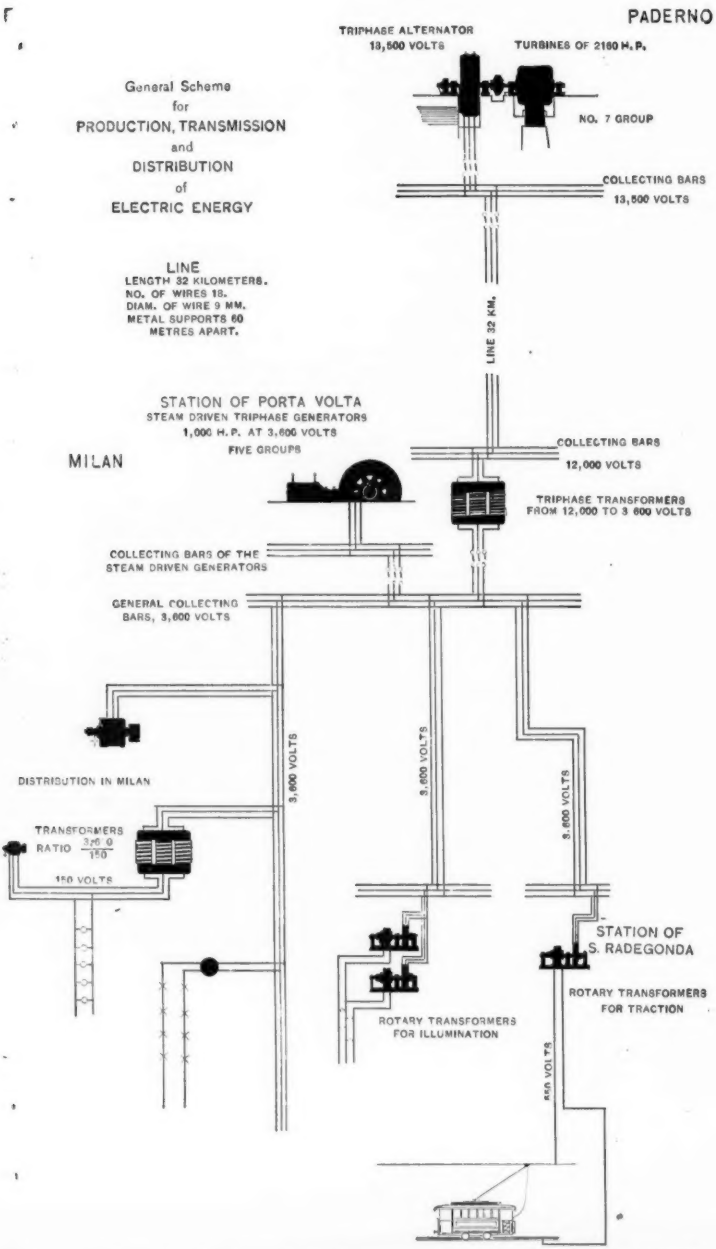


FIG. 21. GENERAL PLAN OF GENERATING, TRANSMISSION AND DISTRIBUTION SYSTEM.

point opposite the station and forming thus a great loop which is the basis of the high-tension network. Two other cables traverse the town diametrically and there is a branch leading off to the Santa Radegonda transformer plant. In conjunction with the principal conduit carrying these cables there are installed substations, consisting of columns built on public ground, or sometimes upon small private enclosures having an entrance upon the street. These substations have a double purpose; they contain transformers for local distribution and also serve as points of discontinuity and branching for the high-tension network. The distribution is made at 3,600 volts only to the larger motors. For all other consumers the tension is 150 volts. The transformers (Figure 22) of each substation feed, so to speak, at 150 volts a small local network composed of underground cables, the mean radius of such a system being about 1,000 feet.

FIG. 22. CONTROLLING AND DISTRIBUTING STATION ON THE TRI-PHASE SYSTEM.

In Figure 23 is shown in diagram the disposition of the circuits and apparatus in one of these transformer pillars. The sketch shows the primary cables, the transformer, and the secondary cables grouped two by two in parallel upon two systems with separate bus-bars. Each of the secondary 150-volt cables is furnished with its own switch. For the primary cables a single switch of the General Electric Company's type serves to cut out any of the various cables. This switch is connected on one side with the bus-bars upon which the primary cables terminate, and on the other side with a second system of bars, inde-

pendent of the first but capable of being put in connection with the cable by means of three movable plugs. The switch serves to connect the cable directly with the main bus-bars, and opening it cuts out all of the local circuits in the substation pillar. It is stated that this simple but new system has enabled the cost of the substations to be consider-

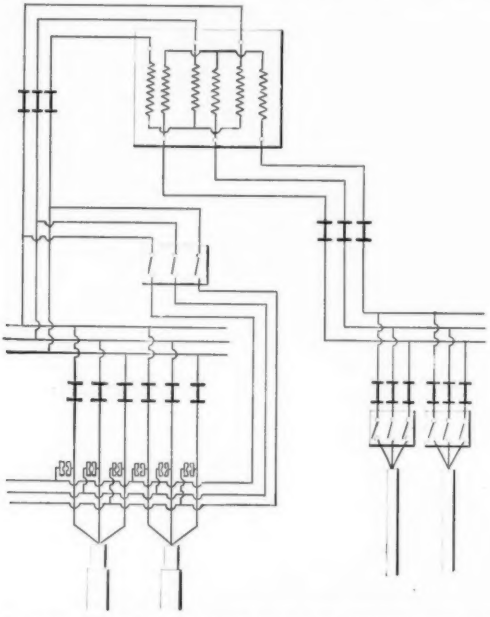


FIG. 23. DIAGRAM OF ARRANGEMENT OF CIRCUITS AND APPARATUS IN A TRANSFORMER STATION.

ably reduced. Lighting installations are fed off the same network serving power users, and it is remarkable how satisfactory this simultaneous service has been to the customers.

The network in consideration is calculated to take care of a power distribution of more than 8,000 horse power with a mean loss of 4 per cent. All of the cables were furnished by Pirelli & Company.

The Santa Radegonda Station:—The second part of the distribution in the city of Milan is made through the Santa Radegonda substation. Four three-phase cables working at 3,600 volts bring current to this station where, alongside of the first Edison steam plant, has been built a transformer station containing all that is of the most modern in the way of machine and switchboard equipment. In this sta-

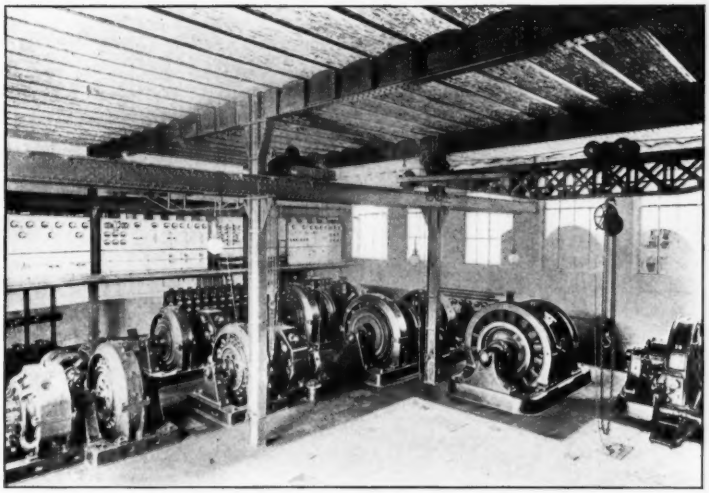


FIG. 24. NEW TRANSFORMER STATION OF SANTA RADEGONDA, FOR CONTINUOUS-CURRENT LIGHTING AND TRACTION SERVICE.

FIG. 25. THE CATHEDRAL SQUARE, MILAN—A CENTER OF THE TRAMWAY SYSTEM.

FIG. 26. ORDINARY TYPE OF MOTOR CAR AND TRAILER, MILAN TRAMWAYS.

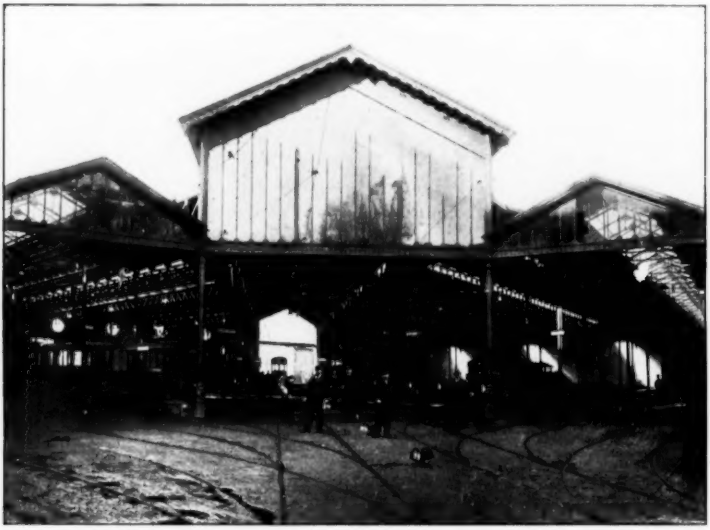


FIG. 27. CAR HOUSE AT PORTA VOLTA, MILAN TRAMWAY SYSTEM.

tion there have been installed five large batteries of accumulators (one for street railways and four for lighting) of the Tudor type, furnished by the firm of Dossmann, of Gênes, and having a capacity of 2,600 ampere hours on a one-hour discharge-rate. The steam-power central station at this point has been for some time finished, as have all its accessory parts. So important are the services that these batteries have already given at the height of the peak of the load and during difficult seasons of bad weather or unusual darkness, that notwithstanding the relatively high cost of the installation the company has reached the conviction that the battery fulfils an absolutely necessary requirement. The batteries are handled through a regulator of the Thury type.

In the same dynamo room are machines of two different classes; those serving the lighting circuits and those giving current for traction. Each machine is composed of a three-phase motor working at 3,600 volts, direct-coupled to a direct-current dynamo. For railway service there are four units of 500 kilowatts each. For lighting there are seven of 250 kilowatts and two of 60 kilowatts. Part of this apparatus was furnished by Brown, Boveri & Company, of Baden, Switzerland, and part by the General Electric Company, of New York (Figure 24). Each of these separate services has its own switchboards. Those handling the lighting current are connected with the boards in the old station with which the new one can work in parallel.

The rotary transformers for the railways are not different from those for the lighting service, except in their output and in the winding of the dynamos on the direct-current side for 550 volts instead of 125 volts, which is the standard pressure for direct-current lighting. Each of these rotary transformers is composed of a three-phase, synchronous, 3,600-volt motor directly coupled with a constant-current dynamo. Preference was given to the use of synchronous motors in place of induction motors (which would present a less difficult problem at starting) on account of other well-known advantages which the former type possesses.

The starting of the synchronous motors in this station is accomplished as follows: Direct current at 110 to 120 volts, produced either from the new or old machinery, is always to be had. The units are started up by using the direct-current dynamo as a motor, feeding it from this current and cutting out resistance in its armature circuit until the apparatus is running at synchronous speed. When this is secured connection is made on the alternating-current side and the apparatus runs in its usual way. In starting the railway apparatus a different

process is necessary, since there is no 550-volt current at disposal to start the apparatus in the way mentioned. The apparatus is started as a motor on the 220-volt current and resistance is then introduced into its field circuit until it reaches synchronism, a special rheostat being installed for this purpose.

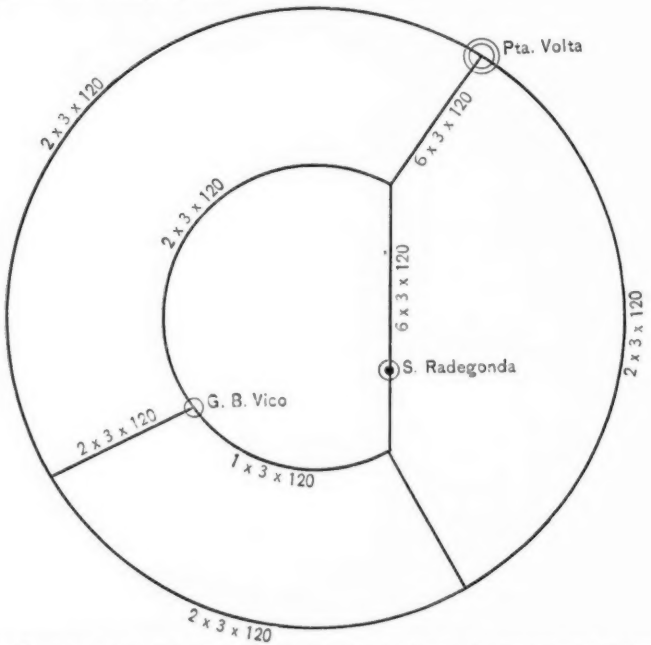


FIG. 28. DIAGRAMMATIC PLAN OF THE PRINCIPAL ANNULAR DISTRIBUTION SYSTEM.

The underground network for current distribution, starting out of these stations and serving the business centre of the city of Milan, is that of the old 110-volt Edison plant, of which the first cable was laid in 1883 (Figure 28). The railways are fed at 550 volts by means of overhead trolley wires, fed in turn through fifteen underground feeders.

The G. B. Vico Substation:—At this station, which is maintained exclusively for the service of public arc lighting, the steam engines formerly used have been replaced by electric motors driven from the three-phase network. At present there are 4,242 lamps used for public lighting and about 600 for private lighting. In the whole city there are installed about 110,000 incandescent lights.

Operation:—From tests made upon the installation at Paderno it

has been concluded that the efficiency of the alternators is 94.8 per cent., and that of the transmission line is 92.6 per cent. The loss due to this long line is thus only 7.4 per cent. In test work the dynamos have been driven up to 20,000 volts and the line pressure up to 17,000 volts. In testing the efficiency of the machines the various losses were measured separately. This loss under full load is almost exactly equal to 5 per cent. and can be subdivided as follows:

Loss by friction and windage.....	1.25	per cent.
Iron losses	2.50	" "
Copper losses	1.15	" "
Losses in the exciter.....	0.10	" "

At full load and under a power factor of 80 per cent. the efficiency is in the neighbourhood of 94 per cent.

During the time of installation of the Paderno plant the work of laying the tramway lines in the city was going on actively and in December, 1898, the last line operated by animal traction—that of the Porta Ticinese—was traversed by electric cars. Milan is one of the few cities of Europe of which the tramway lines have been completely changed over to mechanical traction.* The tramway system altogether has more than 100 kilometres (62 miles) of single track, and 206 motor cars. In all, the company has in commission 260 motor cars and 50 trailers (Figure 26). All of the lines were constructed with material furnished by the General Electric Company, of New York, and the same company also built the electrical equipment of the cars. The

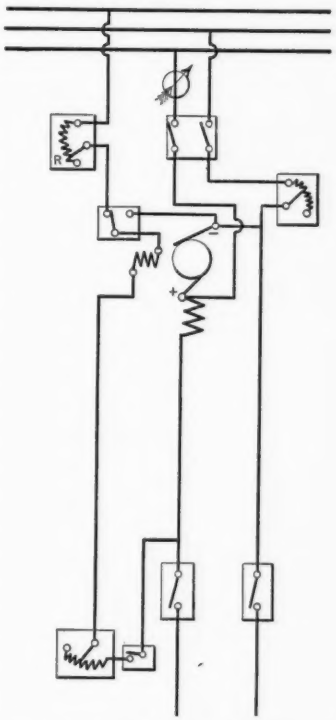
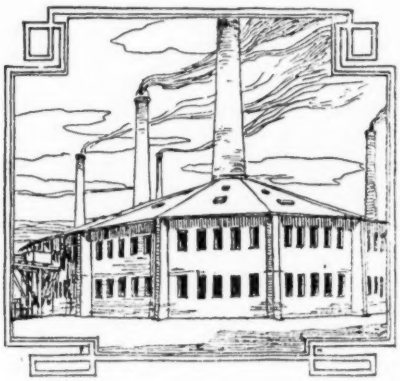


FIG. 29. ARRANGEMENT OF ROTARY TRANSFORMERS FOR TRAMWAY SERVICE.

* This comprises lines already described in THE ENGINEERING MAGAZINE for November, 1900, running out to the Monumental Cemetery and the Musocco Cemetery, upon which there are special cars for the transportation of the dead.

track, of the Phoenix type, was laid by the municipality of Milan and remains its property. Car houses are three in number; one for 200 cars, one for 40, and one for 80. The first, erected at the Porta Volta station, is remarkable for the novelty of its arrangement, which greatly facilitates the going in or coming out of cars (Figure 27). A fourth car house is under construction.

All of the car lines come in to the Cathedral Square (Figure 25), comprising lines lately opened to the public between Milan and Monza, eleven miles, between Milan and Affori, nine miles, and that which will shortly be opened between Milan and Corsico, 3.8 miles. For the line to Monza at Sesto San Giovani, half-way between the termini, a sub-station furnished with a battery of accumulators has been put down, the battery being floated across the circuit and having a capacity of 800 ampere hours at one-hour discharge rate. This station was placed just where the transmission line from Paderno crosses the distribution line and the railway, and receive its power directly from the transmission line by means of conveniently situated transformers.



THE PROPER DISTRIBUTION OF ESTABLISHMENT CHARGES.

By A. Hamilton Church.

II.—VARIOUS PLANS FOR DISTRIBUTING EXPENSE TO INDIVIDUAL JOBS.

Mr. Churchs' first paper, which appeared in our July issue, pointed out the vital necessity of accurate cost-keeping if business success is to be secured, especially in this era of rapid growth and extension of manufacturing enterprises and of increasing keenness of competition. In this article he analyses the chief accepted methods of apportioning general expense to individual jobs, and states their deficiencies, with a view to making clearer the claims of the system which he advocates. His following paper will develop more fully the method of keeping costs by the scientific machine rate and the supplementary rate.—THE EDITORS.

ASSUMPTION is made in what follows that a system of taking out prime costs is already in use, which summarises the expenditure in each department into: (1) Wages and materials expended on stock or customers' orders; and (2) Other expenditure, such as repairs, supervision, and similar indirect items of expense.

Having obtained the total of indirect expenditure for any shop, there are several recognised ways of establishing a ratio or proportion between the value of work done in a given period, such as a month, and this indirect expense. This ratio may be established as a percentage on wages, or expenses may be divided over the numbers of hours worked, or they may be distributed in some approach to a differential method of treatment by means of machine rates varying in value. Each of these methods must be considered in detail.

The Percentage-on-Wages Method. Where any attempt is made to distribute shop charges over work at all, this method is the one most usually employed, at any rate in Great Britain. The probable reason of this is that, though capable of considerable refinements, it is as usually employed a "handy," or in other words a rough-and-ready, method. In order to distribute shop charges on this plan, all that is necessary is to obtain first, the total of charges; second, the total of wages on actual orders during, say, a month in each case, and—find the percentage of one to the other. Thus, if in a given month we have spent:

ITEMS.	WAGES	MATERIAL	TOTAL
DIRECT EXPENDITURE ON ORDERS.	100	56	156
Shop Establishment Charges :			
Repairs and Maintenance	15	4	19
Spoiled Work	2	1	3
Supervision	5	..	5
General Labouring	7	..	7
Share of Storekeeping, Timekeeping, Etc.	..	..	8
Proportion of Rents, Rates, Power, Light, Heat, Etc., for this department	..	..	17
Total of Shop Charges	29	5	59
Total Wages and Material in Shop	129	61	..

We find that as against £100 direct wages on orders, we have an indirect expenditure of £59, or, in other terms, our shop establishment charges are 59 per cent. of direct wages in that shop for the period in question. This is, of course, very simple. It is also as usually worked very inexact. It is true that as regards the output of the shop *as a whole* a fair idea is obtained of the general cost of the work, that is of its works (or No. 2) cost. And in the case of a shop with machines all of a size and kind, performing practically identical operations by means of a fairly average wages rate, it is not alarmingly incorrect.

If, however, we apply this method to a shop in which large and small machines, highly paid and cheap labour, heavy castings and small parts, are all in operation together, then the result, unless measures are taken to supplement it, is no longer trustworthy.

The reason why, under these conditions, it is no longer to be regarded as a scientific method is not far to seek. The case of the difference in the value of work done on different machines as regards one item alone, viz., the interest factor, has already been alluded to. But this is not the only point of differentiation. The space occupied by machines varies, the power taken by them varies. And in the case of men at high and low rates of wages, the cheap man takes up as much room as the expensive man, and probably takes much more supervision; large parts, again, use powerful cranes and occupy the time of labourers in their progress about the shops, to say nothing of the room required for their evolutions.

Now on the simple percentage plan, it is not only that these factors of difference are ignored, but the basis actually used for the distribution of charges, viz., the cost of the job as measured in shillings or

dollars, though apparently a "natural" one, is really quite arbitrary and without any real relation to the actual problem.

That this is so will be allowed when it is considered that the effect *in the costs* of lowering the wages rate of a man, is also to reduce the amount of establishment charges which gets allocated to the job by the system of percentages. If this represented anything like the facts it would not be so bad; but unfortunately, the highest probability exists that by substituting a poorly paid man for a good man on any particular job, the true proportion of charges would be actually increased. He would take longer for one thing, yet as his longer time occupied is counterbalanced by a smaller total of wages, the percentage would not be increased. Again, he would probably absorb more of the foreman's attention, but this would not show in the accounts. In short, the result of the change would really be to increase the cost of the work—the works cost—but the apparent effect would be to reduce it, because the prime cost might be reduced, and the burden of the charges which were before allocated to that job would fall on other jobs with which it has nothing to do.

In certain kinds of businesses it is possible to apply a compensating arrangement. Where the class of work is fairly steady, and the bulk of the work done in any one shop is on different parts of the same kind of machine, certain carefully considered but still to a large extent arbitrary variations of the incidence may be arranged. The work may, for example, be divided into three or more classes according to size of castings, such as heavy, medium, and light, the percentages being so adjusted that the heavy class takes x per cent. more than the medium class, and the medium class y per cent. more than the light class. By this means the whole of the shop charges are distributed as before over the wages expended on orders, but not uniformly. The heavier work gets burdened more heavily than the light work, and therefore absorbs more, while the light works absorbs less than it would have done without this compensation.

The method requires, however, very elaborate and careful arrangements for determining: (1) The basis on which to divide the ratio of percentages, and (2) An equally close consideration of every article manufactured to decide in which class it should be included. Where this is done the method gives satisfaction; but it should not be forgotten that anything like hasty or careless dealing with the varying factors vitiates the value of the whole method. But with proper precautions it is a very convenient and elastic system, if confined to shops which fulfil the conditions above stated.

The Hourly-Burden Plan. The broad principle of this method, in all its varieties, is based on the consideration that the shop as a whole may be considered as a factor of production, and can be charged for at an hourly rate against the work done on orders. The standing charges, the cost of maintenance, and the shop organisation, are summarised as for the percentage plan, but the resulting figure is dealt with quite differently. Instead of spreading the shop charges over the cost of individual jobs, as measured by the direct wages spent, these charges are spread over them according to the number of hours during which work has been done on them.

ITEM.	WAGES.	MATERIAL.	TOTAL.
Total of Shop Charges. (As before.)	29	5	59
Total Hours Worked on Orders During Month—3,000 Hours.			
$\frac{£59}{3000} = 4.7d$ per Hour Worked.			

Thus, if we have £59 as before, representing the whole of the shop charges for one month, we require to ascertain the time actually worked reproductively, that is on orders, and reduce this total of £59 to a rate per hour on such reproductive time. There are variations of this method, but the principle is the same in all, viz., making an hourly charge for the shop organisation and expenses.

A little consideration will show that this method may produce quite a different works (or No. 2) cost from the same set of figures arranged on the percentage plan. It is claimed by the advocates of the hourly-burden method that it is far superior, in that a nearer approach to the real conditions of work, i e., to *facts*, is realised by making the hour rather than the dollar or shilling the basis of distribution. Some of the obvious faults of the percentage system are undoubtedly removed by it. The elimination of wages as the basis of distribution certainly removes the great reproach of the former system, viz., that it makes the works cost on any particular job slavishly follow the prime-cost figures, and therefore tends to make cheap labour bungling over a job for an unnecessarily long time appear profitable. It brings into full prominence the essential fact that to have work hanging about is a costly proceeding, however low-priced the actual labour may be. Perhaps this is the most important feature of the method—it con-

tributes to a clearer view, to more exact picturing, of the immense importance of the time factor in production.

But when we consider the system as fulfilling the role of a scientific method of apportioning establishment charges, it is easily seen to fall short of perfection in a serious sense. Just as the percentage method stakes all upon the single factor of wages, so the hourly-burden plan stakes everything upon the single factor of time. The mere statement of this peculiarity is sufficient to show that we have here a method which sacrifices a great deal for the sake of simplicity. To take one item alone, no discrimination between large and costly and small and cheap machines is brought into play. Simplicity is a good thing, but as an end in itself is worth nothing. What is required is an exact method of apportioning establishment charges, a method which will allow us to obtain figures which are closely approximate to facts, because they follow the actual and known conditions obtaining in the shops, as far as we know how to make them. If any method fails to do this, when it can be done in greater degree by another method, its simplicity is nothing in its favour. At the same time, it may be allowed that for particular conditions the hourly-burden plan will give satisfactory results. In shops, for example, where there is uniformity in the class of machines employed and in the kinds of work passing through, the simple hourly burden gives substantial accuracy. These, it will be observed, are also the conditions under which the percentage plan has been stated to be applicable. The reason of this is not the similarity of the two methods, but because in such cases, *the conditions are at a maximum of simplicity*. In other words, where we have a simple set of facts to represent, their representation is an equally simple matter.

We have here an important key to the discussion of the suitability of any system. Almost any method will represent simple conditions. But will any given method break down when the conditions become complex? This is the touchstone. As work is not arranged to suit methods of record, but *vice-versa*, it is evident that we must seek a method capable of recording with approximate accuracy under the most complex and difficult conditions. We may then feel quite secure that it will also record simple conditions in a simple manner. It is putting the cart before the horse to consider the simple matters first.

The Machine-Rate Method. This is perhaps the oldest and most widespread of all. It is not a modern method. By this is meant that it belongs to a former period, in which the close accuracy, the monthly balances and other refinements of accounting had not been heard of,

and that therefore it cannot be considered as among the scientific systems of distributing shop establishment charges. In fact, it does not usually pretend to deal with shop charges, in the general sense, at all. The usual function of the machine rate is to burden the work with a charge proportionate to the interest on and the wear and tear of the machine. As usually arranged it is an hourly charge, based on the probable life of the machine under full work. In this sense it is intelligible. But cases do exist in which it has been attempted to make it represent more than this, by increasing the amount arbitrarily, so as really to charge part of the shop expenses through it as well. This is exceedingly bad practice. Why it is bad will be seen presently. The machine rate may be looked upon as belonging to the Silurian epoch of shop accounting. It is the ichthyosaurus of expense systems. It attempts to do in a heavy, blundering way what is hardly worth doing at all. Considered in its legitimate aspect—as a means of distributing the burden of interest and depreciation on any machine over the work done on that machine—it does this successfully under one set of conditions only, viz., if such machine is never, for a moment, idle. This being its condition of maximum perfection, it follows that the greater the proportion of idle hours, the less-accurate will be the results obtained from the method. A little consideration will lead to the conclusion that, in a slack time, the work done in the shops will be receiving just the same burden as in a busy time, with every machine running full. The balance of expenditure not allocated to jobs is just lost sight of.

This is a serious enough matter if we consider the machine rate as a charge for interest and depreciation only. But if we look on it, as is sometimes done, as a medium for distributing some (unknown) fraction of the shop charges, the absurdity of the method will be obvious. It will not compare for this purpose with either the percentage plan or the hourly-burden plan. Yet with all its impossibility as a modern system, the machine rate has certain practical advantages, shared by no other method. It *does* take into account just what is missed by the former systems, viz., the variation in the cost of work done on different types of machines. This feature, which practical instinct easily recognises, has secured its survival. Though it cannot be considered as a good method, it has had its value as a compromise between bare prime cost and a regular apportionment of charges. It tells something definite—something which is valuable, but which is neither as definite nor as valuable as it might be.

The fact that it establishes a permanent relation between the work

and the machine is a valuable feature. By a permanent relation is meant a relation which does not change or fluctuate with conditions of work in the shop. The charge for the machine being always *x*, whether the shop is slack or busy, brings a very steady factor into account which is available as a datum of comparison between work done at different periods as no other factor is available. The prime cost, for instance, is no absolute guide for comparison of efficiencies, since rates of wages vary not always in direct proportion to personal output. The shop charges on the two former systems also fluctuate violently, but the machine-rate value remains constant. This is because it is a pure function of time. It is true that for all practical purposes the time itself is the very factor which it is desirable to know. And remembering this, it is not difficult to see that we can obtain this information without necessarily being bound to a non-fluctuating charge.

General *Résumé* of the Foregoing Methods. There have now been passed in review the three fundamental methods of allocating shop charges over work so as to produce works (or No. 2) cost. Of these only the first and second give a real No. 2 cost in the sense that *all* the charges for a given period are spread away over productive work.

It will have been seen that there are two distinct ways only of doing this. The charges must be distributed either on "wages value" as a basis, or on "time occupied" as a basis. For ordinary manufacturing operations there is no other alternative. In certain special industries a distribution on units of weight or measure might be necessary, but we need not pause to consider these. Generally speaking, we have to choose between wages value or time as a unit on which to distribute.

The weak point of the percentage and the hourly-burden system is that it is an *averaged* result at which we ultimately arrive, and which we try to regard as the true works or No. 2 cost. Now, it is just as wrong to average such charges as it would be to throw all wages paid into one sum, and average this over the number of hours worked, taking the result as a true wages cost. In the case of wages this is seen to be an absurdity, and no question of simplicity or convenience would be allowed to stand in the way of collecting the actual wage cost of each job in an engineering works. An average-wages charge is easily seen to be misleading and dangerous.

Yet in certain cases where only one class and size of article is turned out in one shop, this averaged-wages cost, although several variations of rates may be included in the total sum before averaging, is not only useful but is actually used. It works successfully in such cases because of the extreme simplicity of the conditions. Only one

set of factors being concerned, viz., a single process and a single variety and size of article, the averaged charge for wages sops up inequalities of rates, which inequalities are not due to exigencies of manufacture but to exigencies of employment. Here we have an excellent example of a method of accounting, correct within narrow limits, but obviously breaking down the moment those limits are exceeded. The impropriety of applying such a system of averaging wages to a shop in which several processes, different grades of workers, and separate sizes and classes of articles are concerned needs no argument. It can be realised at a glance. But this case of wages is exactly on all fours with the case of shop establishment charges. Under very simple and uniform conditions, a method of distributing establishment charges which averages such charges per shilling of wages or per hour of time is correct, but in proportion as we depart from these simple conditions we also depart from accuracy.

This is not a mere theoretical and pedantic distinction. These shop charges frequently amount to 100 per cent., 125 per cent., and even much more of the direct wages. It is therefore often actually more important that they should be correct than that the actual wages cost should be correct. If we have to put sixpence and also ninepence in a certain collecting bag, it is certainly more important that the ninepence should not go astray than that the sixpence should be looked after.

It is true that by no possible method can we avoid averaging shop charges to a certain extent. But we can reduce this extent to a minimum, thereby attaining a high average of accuracy. In the end we have, of course, to choose between one or other of the alternatives already mentioned, viz., wages or hours, for the distribution. Yet by avoiding the attempt to force simplicity of results into the representations of conditions which are by no means simple, and by letting our method follow the natural lines of the actual complexity, we can arrive at results which are no longer averaged to anything like the same extent, but are on the contrary highly differentiated.

The Elements of an Ideal System. A little preliminary consideration may be given to the features which might be looked for in an ideally perfect method of inter-connecting establishment charges and work. Having entirely cleared one's mind of any traditions of what is usual or conventional under the averaging *régime*, it becomes visible that several of the items of shop charge are naturally connected with the use and employment of property or plant, and are in the nature of a rent paid for these. In this category are:—Rent, taxes, and in-

surance on buildings, interest, depreciation on machines, on cranes, shafts, motors, etc. Other items are connected with other factors of production. Power, with the use of same by machines; cost of lighting or heating, with area of floor space usually lighted or heated—in short, not to go into detail at this stage, it is readily seen that a large number of shop charges are by no means general in their real nature but can be narrowed down to definite points of incidence.

In an ideal system, it would therefore be expected that this narrowing down should be carried as far as it was practically profitable to do so, and that only such expenses as were wholly general and could not by any reasonable analysis be connected with definite points of incidence, should be treated as general shop charges, and therefore left to be averaged on the former basis. This looks complex. And undoubtedly under the most favourable circumstances the preparations *are* complex; but, as will be seen, a working method (which after all is the only thing in which simplicity is important, or at any rate essential) can be devised which is not more troublesome than other methods of distributing shop charges. Before going on in the ensuing articles to explain in detail the preliminary steps and the methods of working, an idea of the new point of view on which the method advocated is based will be given.

We have seen that it is a very simple matter to represent the conditions of a shop in which the work is uniform and all the conditions constant. All the charge factors, whatever their real point of incidence, press equally on all portions of the work in such a shop, and there is therefore no differentiation between different portions of the work possible. In a mixed shop, on the contrary, these factors do not press equally,—power, floor space occupied, with its burden of rent, interest, insurance, lighting, etc., interest on capital outlay for machines—all vary as between jobs. There is no justification for treating such charges as an average if it can possibly be avoided. Hence it is evident that in the distribution of such charges the shop can no longer be considered as a unit, but something smaller must be taken. Of course, to subdivide the shop into smaller areas would be no solution of this problem. The mixture of the factors of incidence would be as great in half a shop as in a whole shop. A new point of view is necessary.

It becomes desirable to look at what the expression "shop" really signifies. If we regard the shop as an organic whole (which it no doubt is, or should be,) we get no new light. We may perceive clearly enough the cross-fire of factors of incidence bearing unequally in dif-

ferent parts of it, but are no nearer their disentanglement. But if we regard the shop as a collection of small "production centres," each differing from the other, with certain common connecting bonds which are alone the average or general factors of incidence, then the problem suddenly becomes clear. If, instead of turning our energies to cover up the natural differences between these "production centres" and make an average of them, we devote our attention to giving the fullest play to this difference, we may claim to have subdivided the shop in a new sense, and to a new end.

A production centre is, of course, either a machine, or a bench at which a hand craftsman works. Each of these is in the position of a little shop carrying on one little special industry, paying rent for the floor space occupied, interest for the capital involved, depreciation for the wear and tear, and so on, *quite independently of what may be paid by other production centres* in the same shop. Then, in addition to this, there will be a separate debit representing those items of incidence which can only be treated as an average all-round charge. The cost of each production centre is, of course, laden onto the work by a rate per hour. Here we seem to have come back to a machine-rate method, subject to all the defects of that method, particularly as regard the idle hours. If the new process ended here it would be of little use, but it does not end here.

It will be seen, when this portion of the subject is reached, that whilst the rate for the production centre is kept constant, the waste of resources due to idle production centres is not lost sight of, but finds its due place in the works cost simply enough, and in such a way that it has a special significance of its own.

One prominent advantage of the plan of reducing each shop to its constituent production centres as a basis for distributing establishment charges should be noticed. The most heterogenous processes may be carried on side by side. Having narrowed down the greater portion of the shop charges to their fundamental points of incidence, we need no longer be afraid of any conditions, however complex. Unlike the averaging methods, almost any actual working conditions can be faithfully represented on this system. This is because each production centre is virtually independent of any other, and therefore complexity is indifferent to it.

It will be seen, for instance, that it is applicable to heavy engineering work, to mass production, and even to that most complex class of work, in which almost-automatic machines work side by side with ordinary machine tools.

THE MANAGEMENT AND CONTROL OF THE COLLIERY.

By William Blakemore.

In a preceding article, Mr. Blakemore reviewed the broad scope of the colliery manager's duties underground. He now takes up the control of the hoisting and surface arrangements, which display in even greater degree the comprehensive mastery of mechanical appliances, labor management, and organizing ability demanded of the modern mine manager.—THE EDITORS.

HAVING reviewed briefly in a preceding article the matters which claim the attention of a colliery manager underground, we pass to a consideration of the hoisting and surface arrangements. On the latter subject little need be said, because practically the direct hoist has not been superseded. Various methods of applying a balanced weight have been tried. The only one of any importance is that resorted to in the Koepe system, which has a return rope from the under side of the cage; but without entering into details it is safe to say that this need not be seriously considered at present. As to whether a steam or electric hoist should be used depends upon whether a natural water power is available for generating purposes. If so, it has been amply demonstrated that whether for a single large mine or a group of mines, it is economical to generate electrical power at a waterfall and to distribute it from one central station. It will pay to do this for a number of mines when steam has to be resorted to for generating electricity. On all grounds it is cheaper and more efficient to have a central station than to attempt to set up a number of individual electric plants at the several mines. If steam is used, it may be said that the day of low pressure has gone by, and that the best type of boiler is the water-tube, with working pressure of 180 to 200 pounds. Geared engines are going out of use as large outputs are becoming the order of the day, and there is probably nothing better in ordinary cases than coupled engines with automatic cut-off and a piston speed of 250 to 400 feet a minute. For hoisting from great depths and with a large load, the most recent development is in favor of compound condensing engines, and where

the extent of a mine warrants the outlay the manager gets the finest hoisting plant obtainable in this. Conical drums, grooved to suit the ropes, are being used, as they are easier on the engine at starting and stopping. The guides in the shaft should either be wire ropes with tension weights or steel rails bolted to the buntons, and as a matter of course for the rope working in the man shaft a safety detaching hook will not be forgotten.

The most important thing in connection with surface works is the general lay out. Commencing with the railroad tracks, these should be set on a grade of 0.60 per cent. if straight or 0.75 per cent. if curved. There should be as many parallel tracks at the screen house, or at the foot of the breaker, as qualities or sizes of coal to be loaded, and the grades should continue below the loading point so that when once cars have been pushed up to the top of the "grid-iron," as this series of tracks is well called, they will fall by gravitation to the point where the outgoing train is made up. Where this arrangement can be carried out no locomotive nor even horse is required upon the surface railroads.

In the case of a screen house, which is required generally speaking where domestic trade is done and the coal is to be divided into a number of sizes and qualities, the elevation above tracks need not exceed 30 feet, and the shaking or oscillating screen with reverse shoots will make three or four qualities, say large coal, nut, egg, and fine. Where the coal contains an admixture of shale, stone, or other impurity, a picking table will be necessary; this may either cross the tracks at right angles or run over them on parallel lines. In the case of hard coal or coking coal which does not require to be picked, the elevation and the tracks require to be arranged upon a different principle. The breaker will be at such an elevation as to allow of a bin being constructed below to hold whatever quantity of coal may be desired, from which supplies can be drawn to the cars from underneath. Such bins vary in capacity from 1,000 to 5,000 tons, and are a great advantage in cases of break-down or accident of any kind which hinders the output. Where it is not possible to make the adit into the mine at the same elevation as either the screen house or the breaker, a conveying plant will be necessary. The most favorable condition, however, is where the grade of the level entering the mine can be continued to the point where the coal is dumped. Even so apparently trifling a matter as the choice of a tippler will have an important bearing upon the efficiency of the screen house, as nothing is so apt to cause delay as a poor tippler. The feature governing this is, of course, the tonnage required

to be passed. The most efficient for a large tonnage is one in which the tub after emptying runs through the tippler and is returned to the haulage track by means of an elevator or creeper. This method avoids the delay incident to drawing the tub back, and enables as much as 2,000 tons a day to be passed over a single tippler. If the coal is required for coking purposes and contains impurity, especially sulphur, it may be necessary to resort to a washer. This should be erected near the screen house, and the fine should be carried from the screen in a conveyor. The effect of a good washer is very pronounced, and has resulted in the conversion of an inferior, unmarketable coke into a first-class article. It is possible to reduce the sulphur by at least 50 per cent. and ash by 75 per cent.

Where coke ovens are used it is an advantage to build them as near the mine as possible, without, however, coming so near that the latter will be affected by the smoke and sulphur passing with the ventilating current; a distance of 1,500 to 2,000 feet will generally obviate this. In some cases it is practicable to carry the coal by means of a conveyor direct from the breaker or washer to the coke ovens. Failing this, the simplest method is to haul special hoppers direct from the mine over the ovens and charge them from the track. Where this cannot be done, owing to distance or other considerations, there should be a high-level and low-level track at the ovens, and a storage bin between the two, the bin to be charged on the upper track and to feed a lorry for charging the ovens, which may be worked either by electricity or steam.

A good manager will want to see upon his plans exactly what is going on in the mine, and this necessitates the employment of a competent surveyor who will keep the plans well up-to-date, not relying in the slightest degree upon the magnetic needle for his underground work. An up-to-date plan will show, by some distinguishing means, haulage roads, air ways, water courses, working places, faults, with their direction and rise or dip, the inclination of the strata, the level of various points in the roads and workings from a given datum, the thickness of the seam at different points, especially noting any variations and the date of the last survey. In addition to this the manager will require an estate plan showing the surface of his property with all buildings, erections, and water courses marked thereon, and a third map showing generally the contour of the surface, so that he can easily determine the thickness of the overlying strata at any given point.

The foregoing article treats of the relation between the manager and his work. There is space to refer only briefly to his relations with his

employers and with his subordinates. The former will expect periodical reports, which should be full, explicit, and lucid. They will partake of a threefold character—technical, financial, and advisory. The former will give particulars in detail of the works in progress in all departments, with special reference to construction work and contemplated new developments. The second will furnish items of cost and will deal generally with the finances of the mine. The designing of a good cost sheet is one of the most difficult tasks which a manager can undertake, and although it may appear to be rather the work of an expert accountant, it must really be the production of the two, because every manager worthy of the name has his own ideas, and can import valuable features into a cost sheet which the man of figures is ignorant of because he is not a practical miner. An ideal cost sheet shows at a glance the cost in each department, the cost of each separate operation in connection with mining, the cost of surface as distinguished from underground works, the cost of material as distinguished from labor, and the cost of motive power distributed over the various departments which use it. The advisory report partakes of the personal and should give in a clear and concise form a review of the work since the previous report, with recommendations for the future, and in this the manager should always be careful to prepare his employers for any impending difficulty, whether in connection with the mine or the workmen.

There was a time when employers were apt to treat mine managers very cavalierly. That time has gone by, and today the relations existing between them are as a rule of the most satisfactory character, due largely to a better appreciation of the responsibilities and dangers of the calling, and largely to the fact that the urgent necessities of mining developments have produced a better class of managers whose abilities entitle them to respect.

The mine manager is well-advised to insist respectfully but firmly upon a free hand, and to refuse to allow directors or employers to interfere with him in matters of detail, or to make themselves too prominent in connection with the affairs of the mine. Their duties should cease when they have determined the policy and given their manager general instructions. It rests with him to carry them out, and if he fails to do so they can get rid of him; but the manager who tolerates interference is signing his own death warrant both with his employers and his workmen. The results which mine owners expect from their manager can be achieved only by a thorough system of organization carried out with consistency and singleness of purpose.

Although the important works referred to above have to be carried out by other men, he will have to design them and will therefore require to exercise the wisest discrimination in the selection of his subordinate officers, and if he allows any other consideration than that of absolute fitness to weigh, he will be the greatest sufferer in the end.

In the case of a large mine every manager should have an assistant, to share not his responsibility but his work, and such an assistant may be a young man, fresh from a mining college, who, whilst acquiring practical experience necessary to fit him for his career, will furnish just that kind of help which a manager most stands in need of, and at a moderate salary.

The next requisite is a thoroughly efficient and experienced under manager, who will spend the whole of his time in the mine and supervise every department, reporting promptly to the manager on any matters of importance coming under his notice.

Each section of a mine should have an "over man," as, however efficient the workmen may be, it is found in practice that it pays to have a "boss" in every separate section, not merely to see that the men do their duty but to handle promptly and effectively any of the thousand-and-one difficulties that are continually cropping up.

Examiners of working faces and shot firers should be also steady experienced men, and in this department in particular the question of character is highly important, because the duties of the position are so intimately associated with the safety of the men. It has been found advantageous to have one or two road examiners, whose duties are confined to supervision of the tracks and calling the attention of the road gang to any defect which they discover.

Upon the surface there should be a foreman at the screen or breaker, and where there is a coking plant a day and night foreman at the ovens. In addition, whether there are machine shops at the mine or not, a thoroughly practical mechanical engineer is necessary, who should have at least a small fitting shop to do repairs. His hands will be full in seeing that the machinery is in running order and that the wheels are kept turning.

In the case of electricity being used for any purpose an electrical expert is necessary, in consequence of the liability of all electrical appliances to get out of order. The manager's office should be at the mine, and whilst insisting upon the various heads of departments doing their own work, and doing it thoroughly, he should see for himself by frequent visits inside that his instructions are carried out, and by thus coming in contact with the workmen, he will, if a reasonable

and diplomatic manager, gradually acquire a personal influence over them, which will not be without its value when matters of dispute arise.

The manager who thoroughly understands and has well organized his work, however large the mine, can sit in the office with his finger upon the pulse of every department, and know by the series of reports which should be placed upon his table every morning, exactly what has been done since the previous day, what the output has been, what accidents if any have occurred, what hindrances and the cause, what workmen have been absent, what material has been sent out of the warehouse, and what the actual cost of production has been within the previous twenty-four hours.

In these times of excessive competition and of such low costs as were not dreamt of even a few years ago, all this is necessary if a man would be master of his work. It can be done, and done easily, if everything about the mine proceeds upon a method; and when it is done, although the anxieties, responsibilities, and risks of the calling are probably heavier than in any other, unless it be that of the mariner, there is compensation in the satisfaction with which a colliery manager can regard the successful discharge of such multifarious duties, which makes him of all men the most devoted to his calling and the most unwilling to exchange it for another.

REPETITIVE SHOP PROCESSES AND INTERCHANGEABLE MACHINE PARTS.

By Barton Cruikshank.

The genius of modern mechanical progress has three great attributes—specialization, standardization, intensification. These represent the natural development of the use of power and machine processes, and it is by moving freely in accord with them that the United States and Germany have made so marvellous an industrial advance.

Their characteristic manifestation, in the field of mechanical production, is the transference of almost all functions demanding skilled manipulation, high accuracy, and tireless energy, from the mechanic to the machine. The operator becomes not merely a dexterous manual workman but a trained intelligence, supervising the materialized intelligence of the designer as embodied in the tool. And with these new machines should go new methods, similarly designed to eliminate the "personal equation"—the varying individual weakness—of the workman. It is with such methods, applied to the small shop, that Mr. Cruikshank deals.—THE EDITORS.

ERY naturally, the details of the management of any individual shop working on the interchangeable plan must, of necessity, vary with the work, and even in the same lines of work it will be different in different parts of the world owing to social and other elements; but all shops, whether manufacturing a staple article or doing job work, whether building light or heavy machinery, should be organized and run in accordance with a few fundamental rules. There are undoubtedly others than those I shall formulate which would be applicable to all shops; these, however, are certainly such as would, on a moment's thought, occur to anyone.

First:—The draughting room should be managed according to some simple rules, such as:

(a). All work made in the shop must have a record filed, either as drawing, or sketch, or written description.

(b). No drawing shall leave the files without, in some way, having been charged to the person taking it.

Second:—There should be a tool room, in charge of one man and with some such rules as these:

(a). No workman, except the assistants of the one in charge of the tool room, shall have unrestricted access thereto.

(b). No tool shall be drawn except in exchange for the workman's own check.

(c). No tool check shall be returned to the workman until the tool for which it had been exchanged has been examined and tested by the tool-keeper.

Third:—No workman should start on a new piece of work without making record of the time spent on his last piece of work.

Fourth:—A system of book-keeping should be arranged for each shop, whereby by noon of each day the cost of each piece up to the evening before could be quickly and intelligibly ascertained.

Fifth:—There should be a stock room from which stock could be drawn only on a special blank provided for the purpose.

Sixth:—A constant inventory of stock should be kept by entering daily the blanks above mentioned, and a daily report should be made to the superintendent when the amount of stock on hand falls below the amount decided upon as just sufficient to carry the demands until new can be secured.

In considering more specifically these rules, I hope to be pardoned for citing some of my own experiences, trying, from them, to point out general principles and methods.

Nine or ten years ago I took the superintendency of a works where they were turning out over 3,000 machines a year, supposedly with all parts built on the "interchangeable" plan. In this shop there were no drawings of the machine, nor of any of the special tools used in its manufacture, nor were there records of the exact sizes of the different "stock" used in its construction. Each contractor had gauges and worked to them for his own convenience, but there were no standards with which to compare these gauges so that, by changes of from one to four thousandths, caused by different rates of wear in the different gauges, each contractor had come to have a size of stock which he demanded, but which differed but very slightly from some other used in the same machine; none of these sizes corresponded with any standard used by the manufacturers. By making record of all the sizes, and taking some standard size near each of the groups of those sizes which seemed originally to have been the same, it was possible to cut down the assortment of stock to about one-half the number of kinds carried before this system was started. To insure an accurate and constant knowledge of standard sizes, therefore, the model shop should have in its draughting room a system by which, in a moment, any drawing ever made or used in the shop could be found.

To go into details on the subject of care of drawings may seem to some superfluous; but my experience has shown me that many shops do not know the true value of a well-arranged file of drawings, or,

knowing the value, have not the skill or perseverence necessary to carry out a successful plan. Methods must, of necessity, vary with the different shops, but slight changes worked upon the one I have successfully used would, I think, make its best features available for almost anyone. In the first place, all my drawings had to be on one of three standard sizes. For drawings of special tools or of machines of which we should probably build but one or two, we used a yellowish paper mounted on heavy straw-board. After the drawing had been inked with waterproof ink, it was given a coat of white varnish before being taken into the shop. The upper left hand corner had the "catch number" and the name of the tool or machine. Drawings much to be used were made on the same mounted paper, but were left in pencil and tracings were made from these. For filing, the tracings were fastened to the pencil drawing with a paper clip. The blue prints also were varnished and were mounted as above described on heavy straw-board. Each board had a ¾-inch hole in the middle of the top margin, and each workman had directions not to handle his drawing with greasy hands but to leave it hanging on the wire provided for it over his bench, to report to the superintendent if any dimensions were missing, and never, under any circumstances, to "scale" the drawing.

For filing, cabinets made in different sizes to fit the different sizes of drawings are necessary. The small size takes all standard octavo catalogues, all papers from the American Society of Mechanical Engineers, and all index cards referring to numbers of drawings or other desirable memoranda. For clippings, manila envelopes, 6½ inches by 9½ inches with Acme library card pockets mounted on them are used. The catch word is placed upon the envelope and the cards are placed in the pocket. Should the catch word of a new envelope come between some of the cards already in a pocket on one of the envelopes, those cards ranging alphabetically before the new envelope would be put into the pocket on it and both envelopes and their respective cards arranged alphabetically in place. In very large works where the catch word would be at all apt to lead to confusion or the oversight of an article, the Dewey decimal system, now so much used in public libraries, might perhaps be employed to advantage. The same style cabinet, but larger, works admirably for drawings mounted as above described. Our drawing tables had an edge of hard wood projecting the thickness of the straw-board above the table to enable the T-square to work smoothly.

The Tool Room.—Anyone who has been long in a shop where there was no tool room is fitted to judge as to the amount of time

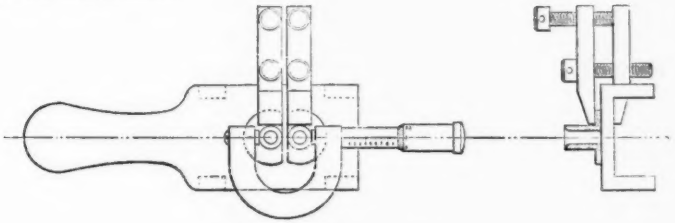
wasted in hunting for tools with which to begin the work. Does it not often, in such a shop, take longer to hunt up the proper size of tap drill and then to find the drill than to drill the hole and tap it? But in the properly laid out tool room, the taps and the tap and body-size drills all lie in correlated compartments of the same shelf or drawer; one check draws taps and tap drill, a second check being necessary to draw the body-size drill or the bottoming tap. This homely illustration does but show one of the hundred other like experiences that a day's comparison of two such shops would bring forth. And the tool keeper, if a trusty, clear-headed man, can keep busy, even in a small shop, to the decided advantage of the profit side of the balance sheet, even if he does nothing else than keep thoroughly in repair the regular and special tools of the shop, though often he may be able advantageously to work on new tools or other regular work of the shop, his tool-room necessarily being fitted with the best lathe and universal grinder purchasable.

In the tool room are kept not only all the standard tools, such as taps and drills, reamers, arbors, etc., but also the special tools. A discussion of the many different styles of these, as they are now used in the best shops, is not possible in this paper, though future descriptions of such by others working on these lines, will, I hope, be the result of this article.

Since two or three makers of turret lathes have added to the range and variety of work possible by dropping the old turret form and substituting a horizontal face plate with its wide range of motion and position for its special tools, the catalogues of the makers of such lathes have become, in themselves, text books on machine design and shop organization. The drill jig, the milling-machine fixture, the shaper and planer attachments, are, however, seldom described. Each shop has its own peculiar style, and but few men have opportunity to make a comparative study of even general types. One thing, however, is common to all shops making repetitive parts. This is the drill jig bushing. I shall insert here an article of mine presented at the New York meeting (December, 1893) of the American Society of Mechanical Engineers, and forming part of Volume XV of the Transactions, only regretting that I am unable to give also the several valuable additions to our literature on shop practice which immediately followed.

"The following simple plan is submitted as leading to good results in the making of drill jigs. This is a well-known device in some shops, but, not being universally used, a brief description of it would perhaps be of interest.

"Where two holes are to be placed in the jig in the same flat surface, at a given distance from centre to centre, they can be quickly and accurately located by the use of hardened-steel bushings ground to a known size on the outside, and lapped out to fit very accurately the drills and reamers which are standard for the tits of counterbores in use in the shops. By using the same tit size for several sizes of counterbore, the number of bushings necessary for all round work could be considerably kept down. These bushings should be made with a flange or other projection, so that with clamps they may be temporarily fastened to the jig, as shown in accompanying sketch, the distance from the outside of the one to the outside of the other measured with micrometer or vernier caliper, and the holes for the counterbores drilled and reamed.



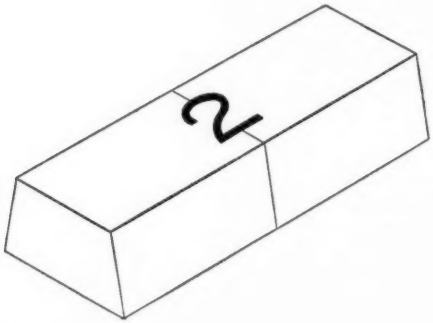
A DEVICE FOR DRILL JIGS.

Reproduced from the Transactions of the American Society of Mechanical Engineers.

"This is not new nor my own device, but is so handy that it should be more commonly used in shops where sufficient jig making is done to warrant the expense of the few bushings with counterbores to fit."

The special-tool designer has indeed a broad field in which to exercise his powers, and the tool-maker has oft-times jobs which to the layman seem impossible—such, for instance, as the set of tools for the manufacture of the automatic bank-check punch, which I cite not only to show a sample of the kind of article which should, I think, be written as a sequel to this, but because the methods used in its construction, in addition to being models of good tool-making, were examples of far-seeing, systematic shop management. The tools were made in duplicate and one set sent away to the safe-deposit vaults, but their painstaking did not stop with these efforts to insure against losses, errors, and changes. This will be seen from a description of the making of one of the punches and dies—say for the figure 2. First a two-piece die was made, fitted into a die holder or bolster, and hardened and lapped so that it was as perfect as tool-maker could make it.

Next a steel punch was made to fit into this, and a duplicate die made to fit the punch. This punch and the second die were used to make the dies used in the machine proper. These dies are made of discs of thin tool-steel, and can be seen in almost any bank on the machines themselves. Die number one was then taken apart and a lathe tool was made to fit each half. With these lathe tools, milling cutters were made. Then a drill jig was made in which to drill the ends of the rods used for the punches in the machine itself, the hole drilled forming the inner circle of the figure 2. Then two fixtures were made to hold this same piece of stock in the milling machines where the above described mills did the forming of the rest of the figure 2. The finished machine punch thus made must fit perfectly into the original die to which were fitted the lathe tools which formed the milling cutters which made the punches. From this it can be seen that accuracy of workmanship is the first essential, taking it for granted that we must have a good design.



After the many able papers on cost-keeping—on book-keeping for the shop—which have been placed before the members of our engineering societies and the readers of THE ENGINEERING MAGAZINE, it would seem like presumption for me to speak on the subject did it not belong properly in this place to give in the one article a rounded discussion of shop organization.

A system which will, with a minimum of labor, keep costs in handy form for a shop doing job work can, of course, be readily arranged to meet the requirements of almost any manufacturing establishment. Such a system I shall describe. In the shop each workman entered on a time card the name of the job, its number, and the time he had spent upon it, as shown on the following page.

JOHN SMITH. Workman's Number. 27.

February 9, 1901.

Name of Work	Order Number	Part Number	Hours
Drill Jig for Typewriter.....	1762	15	4
Repair—Lathe No. 7.....	127	7	3
Milling Fixture for Check P.....	1813	7	3
			10

This slip was inspected by the superintendent and passed to the bookkeeper. His cost book was ruled in columns, so that from these slips, with the writing of little else than figures, he could give a full history of the work as shown below. The page would be headed with the name and number of the order and under the proper column, in this case the one for part 15, the entries made as follows:

Date 1901	Workman	Wages	Hours	Total	Stock	
2/9	27	32½	4	1.30	4 oz. ⅛″ x 3″ C. R. steel	.02
					2¼ lbs. tool steel	.40½
					1½ lbs. cast iron	.06

In our shops this was a regularly bound volume, but it would undoubtedly be a great advantage to use a binder and sheets that could be alphabetically arranged for each new order.

In the job shop, items for drills, files, emery, oil, waste, etc., were seldom chargeable directly to one job and were therefore kept in a separate account, and, like office expenses, rent, insurance, etc., made a constant per cent. to be added to all estimates of cost. Such items, in a shop running on regular work, could be much simplified.

In keeping a constant inventory of stock, the work was done by a low-priced clerk who subtracted from the amounts already in the columns under the various heads in the stock book the amounts shown to have been drawn from the stock room as found on the requisitions. This inventory was kept on sheets in a flexible-backed binder, so that new leaves could be inserted alphabetically whenever old ones were full or when a new kind of stock was added. At the top of the page was to be found the name of the stock, its size, its cost, and the amount below which it should not be allowed to fall before a report was made so that new might be ordered to insure a constant supply on hand.

In connection with stock keeping it may be interesting to some to know that, against the advice of several practical men, I was able, even in a large job shop, successfully to keep, not only an inventory of files but, with very little bookkeeping, an oversight upon where they went and by whom they were used. A new file could be drawn by the workman without an "O. K." from the superintendent, by presenting at the stock room his own written order and a worn-out file of the same kind. Should he need a file of a different kind, he must get the O. K. of the superintendent upon his order. The page for files was headed with the workman's name and ruled and kept as below:

Smith, John

	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Bastard, 12",	////	//	/	///	/	////	//	///	////	//	//	
Hand, 8", smooth	/	/	//	/		/		/		/		

Let me urge those in charge of shops using special tools of any kind to let the manufacturing public hear not only of the unusual but of the ordinary styles they are using. What is very ordinary to one shop will often prove to be quite new to another. Engineering papers will, I am sure, be glad to publish good papers descriptive of such tools, and schools of technology will be only too glad to find such articles to aid in fitting their students to be not old-style machinists but up-to-date men able to carry into their engineering work-shop methods that will be the integration of all that is best, drawn from the experience of the foremost manufacturers. We have no text books on design of special tools. Do we not need one? Has not the day of building without such tools gone by? Do not the machinists of the United States owe it to their country, now the foremost in the world in the use and manufacture of fine machinery for the making of repetitive parts, to do all they can to make more universal amongst machinists and engineers a working knowledge of special tools and fixtures?

EDITORIAL COMMENT

It is hard to be always an optimist. Our idols will fall at times so far below our ideals that devotion stumbles and faith falters. THE ENGINEERING MAGAZINE has been persistently hopeful for the future of organisation, whether of employers or workmen—confident that in association lay the best road to understanding and agreement—convinced that the faults of trade-unionism were chiefly in the misuse and abuse of its forces, rather than inherent in the system—and steadfast in the belief that time and trial would raise up wiser leaders and establish sound and reasonable principles for its guidance. From this standpoint the agreement of the British engineering master and workmen in 1898 and of the American employers and machinists in 1900 were hailed as a long and substantial gain in the advance to a better labour system.

It was, perhaps, too rapid to stand without a reaction. At all events, the present murmurs in Britain and the recent upheaval in the United States have shaken the quiet which seemed to be settling over industrial relations on both sides of the Atlantic.

* * *

And yet, none of these things weaken the argument for association, argument, and adjustment by mutual agreement. They merely show that there is more for the associations to do than might have appeared some months since—not at all that the associations are incompetent to do what is to be done. There is much for them yet to do, first, in educating their more backward members in sound ideas of right and wrong, of reason and justice, and of sound industrial economy; there is much to do in perfecting their organisation and discipline and the sense of responsibility among their officers and members to the point where an agreement made by the union will have the force of a contract with the individual men comprising it.

* * *

From the confused situation in the United States machine trades come several instructive glimpses illustrative of the work which intelligent unionism has before it in educating, guiding, and controling its weaker members, in instructing them in the relations which must of necessity govern commercial transactions (including the sale of labour) and in the reasonable and sane use of such power as organisation may give. The first instance is that of an "open" shop in Brooklyn and indicates the foolish tone of the small agitator whom a wise and experienced unionism would summarily suppress. The incident opened with the following letter addressed to the proprietor. For obvious reasons, all names are omitted:

"BROOKLYN, May 24, 1901.

"Dear Sir: In view of the present labor troubles and desiring to share as a body in the benefits derived therefrom; we your employees have unanimously agreed to ask you for a reduction of the number of working hours per week, from 59 to 55 as demanded by the International Association of Machinists, without any reduction of money we receive for 59 hours' work. We also hold as a grievance the dismissal of one of our number ——— ———, for no just cause. He has done his duty as he understood it according to the orders of ——— ———, (the foreman) and he certainly should not be blamed for any error he was ordered to commit, therefore, We desire his reinstatement and also the dismissal of ——— ——— (the foreman).

"Trusting that our request will be granted at your earliest convenience, and wishing you a prosperous and honorable career we remain yours very truly,

"The Employees of ——— ———."

Convinced that the letter was the work of some small clique of malcontents, and the "error" of the fellow workman referred

to (grinding down with emery a job which it was the uniform practice of the work to hand-scrape) was not attributable to the foreman, the proprietor made no immediate reply, but undertook a quiet investigation to discover the general feeling in his shop. Then followed the remarkable note appended :

"June 26, 1901.

"Sir: Several weeks ago, we the long suffering employees of your establishment asked you in a letter to shorten our hours of labor. We left it to your discretion to do as you pleased and you did nothing. Now dam you, we demand it and if we do not receive any more satisfaction than we did before, every damned man and boy in the place will go out next Saturday, June 29, and will not return or allow you to fill their places, until our demands are granted. Now damn you, put that in your pipe and smoke it, if you have one.

Resp. Employees ———
per J. W."

The proprietor thereupon promptly decided to ignore the matter, and went away on his vacation, leaving the foreman in charge. At the time of our latest advices, about the middle of July, "every (self) damned man and boy in the place" was still working. So much for the folly of unorganised labour.

* * *

The second example is of organised folly, and is found in our correspondence from one of the western States. We quote the letter *verbatim*, excepting only names :

"In the ——— ——— machine shop of this city (Detroit, Mich.) Mr. ——— did not join the local association (National Metal Trades) when the strike came on, and after the men were out one week he agreed to their demands, so far as the nine-hour day and 12½ per cent. increase were concerned, and the men returned to work. Yesterday one of the men refused to work on a piece of work and Mr. ——— laid him off, telling him that when he got some work that he could work on he would have him come back. A committee from the union at once waited on him, and demanded that he take the man back and find work for him. Mr. ——— said he was unable to do this, and as a result they called out all of his men again. Mr. ——— is now considering the advisability of joining our local association, and at least will co-operate with us. We believe he employs about thirty men in all, and for about twenty years has had no trouble in his shop until this spring. We think his case is a good one to place before any weak-kneed members of the association."

* * *

Organisation does not of itself immediately confer wisdom, but it establishes the machinery by which wisdom may be disseminated, and through which, we yet believe, wisdom will ultimately gain the control. As Mark Tapley said, there is no credit in being cheerful when everything is comfortable; we claim the credit of holding cheerfully to an optimistic view of organisation and arbitration, in spite of present apparent discomfiture. A keenly interested observer of industrial conditions said lately: "These questions can't be fought out; they must be *talked* out." Strikes and lockouts lead only to forced settlements and lasting bitterness. Argument, education, conviction will lead to permanent adjustment with mutual content. And organisation and conference afford the means to these ends.

* * *

It has been pointed out often in these pages that one of the most important results from the spread of the newer system of traction and propulsion was the considerable economic change they brought about, through altering the time-and-money conditions in the movement of passengers or goods. The bicycle had a distinct influence in altering the distribution of population, and of course a much plainer one in increasing the volume of short-distance travel—rather unexpectedly, to the advantage of the railway also. Cycle-and-rail tours brought a new class of business, probably very many times as great as the business lost through the adopted use of the bicycle by former short-distance railway travellers. Next, the "trolley" played a much larger part in enlarging the radius of convenient and desirable residence near urban centres and in redistributing population in accord with the new conditions and possibilities of local transport. And now the electric tramway is beginning to play a part in goods traffic as well. In New York a special city-delivery service for parcels and

general express business has been put into operation, and its freight cars are operated over the existing electric lines—the undertaking being greatly facilitated, of course, by the fact that the principal lines are now all converted from the cable to a uniform underground-conduit system.

But it is from the motor car that the largest results in improving the economy of distribution may be expected. Just a year ago this month, Mr. F. M. Maynard discussed in the pages of THE ENGINEERING MAGAZINE the advantages of motor-car service, as compared with rail, canal, and horse haulage, for transporting and delivering the product of the factory. In flexibility, convenience, and manifest adaptation to "door-to-door" service without rehandling, its case hardly needed argument; but Mr. Maynard showed further that in reliability, time, and actual money cost, the advantages were strongly with the road car. In Great Britain it has passed its initiatory stage, and further establishments of motor-van service are heard of constantly, a recent one being the projected line between London and Tunbridge Wells, in direct competition with the railway. In the States the movement is not so far advanced—partly because of the poorer roads, partly because of the lower railway charges; but beyond question the heavy motor vehicle has a greater future than the automobile carriage. And it would not be surprising to find again that the railway—which at first sight seems to be bound to suffer from the new order—will eventually profit largely from it.

* * *

Another matter closely connected with the economical transportation of merchandise in which the United States are relatively backward in the parcels post, concerning which a vigorous agitation is now promised. At present the United States have no parcels-post arrangements except with Germany, and the result is that the American exporter—or would-be exporter—of goods in small quantities is effectively shut out of many foreign markets for simple lack of reasonable transportation facilities. An instance is cited of a manufacturer in the States who desired recently to fill a small order from the Argentine Republic requiring the transmittal of a three-pound package valued at $3.00. The only forwarding agency open to him was the private express companies, whose charges on this package would have been $6.30. It was not sent. And it is pointed out that an English exporter, filling the same order, could do so through parcels post at a total cost of $0.57.

* * *

John Wanamaker is credited with having said, when he was postmaster-general of the United States, that there were four strong reasons why the parcels post had not been adopted by the United States—and then he named the four great express companies of the country. The opposition of these private corporations is generally charged with having so far obstructed the introduction of a system which has been so profitably extended by England and Germany, to say nothing of the minor industrial competitors of the United States. But there is another strong factor of opposition, though how far it has been developed and pushed forward as a bogey by the express companies it would be hard to determine: that is, the fear lest an unequal advantage or, indeed, any advantage, be given the foreign exporter to the United States. It is the old protectionist idea over again in its narrowest form. And those Americans who would live in utter tariff-made seclusion, point to the records of the German-American parcels-post as confirmation of their hideous dreams, crying, "We told you so! They are sending us more than we send them! The advantage is in their favour! Away with it all!' And this in spite of the fact that the general trade balance as between Germany and the United States was largely in favour of the latter.

The simple explanation, of course, is that Germany, as the only European country having a parcels-post with the States, is used as a sort of general clearing house for Great Britain and the Continent in all business of this character, and the figures

showing the nominal German business represent in addition the total of English, French, Austrian, Swiss and Belgian parcels-post business with the United States, which get no direct reciprocal advantages with these countries. The American exporter by mail orders has again, as in the case of the Russian business described by Mr. Ford in our July issue, to work by indirection and "underground road" through Germany, to the cumulative advantage of the German who appears as the direct agent in the busir ess. Such conditions can not long be permitted by the American export manufacturer, thoroughly awakened to and vitally dependent on the valuable business to be had in the world's markets.

* * *

Reference was made in these columns some time since to the value of the Engineering Index as a barometer of industrial and technological thought. The waxing and waning of the bicycle—the rapid progress of the automobile—the striking rise of the gas engine—the growing importance of the steam turbine—all are closely gauged by the space occupied in the Index columns. But another attribute of the Index, clearly observable only by those who read for and compile it, is its effectiveness in displaying the reflected thought of THE ENGINEERING MAGAZINE as it comes back from our many exchanges. Thus to quote recent instances only, our leader of December last, on the Anglo-German agreement, was found copied, quoted, or commented upon, in more than eighty home and foreign journals and periodicals. The late Mr. T. C. Clarke's study of American bridge-building, Mr. E. Phillips' review of the British steel-making industry, Mr. Bogle's analysis of the influences affecting the Puget Sound region, and Mr. Ford's Russian papers had fully equal quotation, while nearly equal notice was given to Mr. Redfield's analysis of the prospects for Anglo-American industrial supremacy, Mr. Strong's review of mining opportunities in the Philippines, or Mr. Going's study of industrial communities, old and new. Mr. Diemer's series on Commercial Organization of the Machine Shop spread, in translation, through France, Germany, and Belgium; Prof. Pupin's article on long-distance telephony was done into Italian.

* * *

But someone has defined fame as seeing one's name mis-spelled in the newspapers, and possibly the analogy in journalism is seeing one's self misquoted in the exchanges. We were lately credited—or charged—with an item on the "Origin of Family Names," which seemed quite foreign to our province, and also with a stray paragraph on "Poisonous Plants"—which, by the way, was even unusually full of misinformation. Even a little foundling poem on the Sweetness of Killarney in the Spring was laid on our doorstep.

More curious are the slightly altered paragraphs from the Magazine which occasionally turn up, launched no one knows how, but suspiciously capable of serving some one's purpose under assumed cover of the Magazine's authority. We have previously referred to one, originally commenting upon a possible scarcity of gutta-percha, which was altered by changing "gutta-percha" to "rubber," and then sent out broadcast. Forty periodicals brought back to us our imputed statement that "rubber is scarce." when as a matter of fact every one knew that the possible sources of crude india-rubber are being continually added to at an enormous rate. And the latest changeling is headed: "Markets for Liquid Air. Engineering Magazine. Although liquid air has been in use for many years in the steamships and railways of the Black and Caspian Sea district, etc" Of course, what THE ENGINEERING MAGAZINE wrote was "Liquid Fuel" (Review of the British Press, Jan., 1901, page 779). It might be interesting to know how the changes in both title and body of the article were made, and why.

REVIEW OF THE BRITISH PRESS

The Coal Problem.

IN a paper recently presented before the Society of Arts by Lieutenant Carlyon W. Bellairs, R. N., and published in the *Journal* of the society, the relations of the coal problem to the general welfare of the empire were very fully discussed, and some most interesting points brought out.

After recalling Jevon's statement that coal is "the mainspring of modern civilisation," Lieutenant Bellairs proceeded to show the futility of attempting to prophesy as to its future use or extent of application. In 1871 the royal commission reported that there was reason to doubt whether there would be much further increase in coal exports. That was 30 years ago, while in the past decade the exports of coal reached 358 million tons, there having been placed in the bunkers of steamers during the same period exactly 100 million tons. As a matter of fact the important proportion which coal exports bear in showing the total exports of Great Britain is not always realized, and in examining the extent to which Germany and America have entered British markets for other things a better idea will be obtained by deducting the amount due because of coal exports.

In considering the present commercial relations of British coal to that of other countries there are several points, all of which must be given proper consideration if intelligent conclusions are to be drawn. A most important feature is the cost of transport. The rates of freight on coal on the railways of the United States are about one-fourth of those in England, and in Germany they are about one-half. This and the greater ease with which the American coals are being mined, due to wider seams, less depth, and the extensive employment of coal cutting machinery, give the reasons for their lower prices.

It is a mistake, however, to speak of coal, as a general term, tacitly admitting that a ton of coal is the equivalent of every other ton of coal. On the contrary, the differences in the qualities of coals, causes correspondingly wide differences in prices, and materially complicating the problem. No real comparison can be made of the values of various coals without the fullest information as to the physical and chemical properties, as well as the evaporative qualities.

Considering coal as the mainspring of national welfare, its relations to the empire should include the interests of the empire as a whole. Now naval strength is the safeguard of the empire, and permanent naval strength is based on commercial prosperity, hence to impair commercial strength is to risk naval supremacy. Great Britain possesses a virtual monopoly near the sea of the finest steaming coal in the world. That this coal should primarily be used for the benefit of Britain is imperative, but the exports of quantities of it for the use of the navies of other nations is not without its advantages. Nations which, in times of peace, allow themselves to become entirely dependent upon British sources of coal supply, will find themselves terribly handicapped when at war with Great Britain.

Such considerations might make it appear feasible to restrict the export of certain Welsh coals, or for the acquirement by the State of favourable mines in the interests of the navy, but such a plan is altogether different from the imposition of an export duty on all coal for the protection of manufacturing industries. As Jevons said, coal is Britain's great outward ballast freight and "the inevitable progress of free trade will ever increase the tendency to export coal." In other words, the bulk of the export cargoes to balance the imports of wheat, timber, iron ore, and other raw materials, must consist of coal.

"We may dismiss from our minds all the talk about sudden exhaustion of our coal supplies. It must go through two stages,

though inventions may retard the process. There is a stage at which we diminish our exports and begin to import. We are then nearing the exhaustion of the cheaper supplies. It is estimated that we have at least 20,000 million tons at such depths and of such widths as can make no sensible difference in prices. In addition fresh coal fields may be worked, for borings have been proved in other parts of England besides the well-known cases in Lancashire and Kent. Allowing for 20,000 million tons at an average production of 300 millions a year, the cheap supply would last seventy years. If we assume that one-fifth is wasted, or left in the ground as props, then the cheap supply will last fifty-six years."

The above considerations apply to British coal alone, but when we take the whole empire into account we have the almost untouched supplies of Canada and of India to deal with. With the coming of imperial federation it should be a matter of indifference in what part of the empire industries are developed. The growth of the iron and steel manufactures of Cape Breton is an example of what may be expected in other places. Developments of mining sections take place with great rapidity, as the growth of the coal production of the world in the closing quarter of the nineteenth century shows. The world's output of coal rose from 142 million tons in 1860, to 700 million tons in 1900; of which Great Britain's proportion was 84 million in 1860 and 224 million in 1900.

In summing up the existing position Lieutenant Bellairs concludes:

1. That the shipping trade of the United Kingdom is largely dependent on, and has increased with, the coal trade to the extent of nearly 140 per cent. in 30 years; and that it is undesirable for this and other reasons to restrict the coal export trade.

2. The requirements of the navy can be met by the State purchasing adequate mines. These requirements for a century's supply do not amount to more than four years' output of the Welsh mines.

3. There is a real need for interference in the coal mining industry in the interests of economy, for the provision of reserve coal, and for the prevention of strikes. The compulsory working of mining grounds, the amalgamation of companies, the extinction of royalties, and transport facilities are separate questions requiring investigation.

4. The provision of the fullest possible information concerning coal resources is of the utmost importance.

"No country or empire in the world can show such an increase in the volume of its commerce during the last thirty years as the British Empire. On the other hand, it is unreasonable to hope that the United Kingdom alone can maintain the position it occupied in the seventies as regards the United States and Germany. Then much of the United States was virgin soil, and the German Empire was a young giant destined to rapidly grow. In the quarter of a century following, the population of the United States increased 30 millions, Germany 11 millions and the United Kingdom 8 millions. Our sole hope of predominance lies in our empire. We have to bridge over a period in which imperial federation is being accomplished, and the burden of maintaining our armaments will have to be borne during that period almost exclusively by the wealth and trade of the United Kingdom. Under such circumstances a nation may well spend its capital, even though that capital is coal, the source of its material welfare. That coal is lying unproductive in the earth. In this most critical period of our history, when we are reaching forward in imperial federation to an even greater predominance than we possessed in the seventies, it is essential that we should enhance our production and profitable exports of coal by all means in our power. By acting thus we are able to raise greater wealth for the building of battleships, which enable us to achieve our destiny in peace."

It is a bold idea, but strong because of its very boldness. Instead of husbanding the nation's resources, the capital of the land, in the form of its yet existing stock of coal, should be thrown on the market with all speed, and the proceeds invested in naval equipment to enable Great Britain and her colonies to become the greatest federated empire the world has yet seen. This accomplished the parent island can safely look to other parts of the empire to maintain the coal and manufacturing supremacy she once possessed; serenely reposing upon the laurels of her past, and secure in the strength of the empire of which she forms but a part.

The Liverpool Motor-Vehicle Trials.

In the development of motor vehicles different countries appear to have taken up different portions of the problem, not by any sort of agreement, but rather from the influence of local conditions. In France the pleasure and touring vehicles have reached a high degree of elaborateness, and in the recent race from Paris to Berlin we see the natural result of what must be considered a one-sided development. Another development, also one-sided, perhaps, and on the opposite side from that seen in France, is found in the trials of the Liverpool Self-Propelled Traffic Association. Here it is the motor truck and lurry, for carrying heavy merchandise in competition with horse-drawn vehicles, which has received attention, and as a result of these trials it is not too much to say that England has surpassed all other countries in the development of motor vehicles for heavy traffic.

It is now two years since trials of motor cars have been held by the association, and hence those recently concluded have attracted much attention. This was more especially the case since it was intended that demonstrations would be made which should influence the Local Government Board to consider favourably the proposal to modify the present regulations, under which the maximum tare weight of vehicles must not exceed three tons. At the previous trial all the competing vehicles have been kept within this limit, and the result has been beneficial to the extent of causing great care to be exercised in the use of material and the distribution of weights.

This year, however, in addition to the smaller cars, arrangements were made for the trial of two new classes of car on which no tare limit was fixed, the object being to show the feasibility of extending the limit to a desirable point beyond that of the present rules.

A full report of the trials and description of the vehicles taking part therein is given in the *Automotor Journal*, from which some abstracts are made.

Among the especial requirements in the general regulations we note the following: In addition to the ordinary demands upon motor vehicles, the cars entered for trial shall have sufficient water capacity for a run of 15 miles, shall be capable of starting from rest on a gradient of 1 in 9, and shall be capable of working in and out of an embayment of one-and-a-half times their own lengths. No restriction is made as to the character of motive power, or the nature of the agents used, but with the exception of class C, in which no tare limit is imposed, all vehicles must comply with the Locomotives on Highways Act, 1896. Limiting dimensions and weights are also given for the various classes, as well as the speeds, which are 8 miles per hour for class A, of 1½ tons load and 2 tons maximum tare, and 5 miles per hour for the heavier vehicles.

Space does not permit of a detailed description of the various vehicles which entered in the trials, and the reader must be referred for details to the original report. A few general remarks however, will give some idea of the character of the various cars. In the trials of 1899, all the vehicles entered were propelled by steam power, and it then appeared that this was the only feasible kind for such service. In the present trials, however, there were two petroleum motors, both of which worked well, although being of the same design, they gave no opportunity for comparison.

In the case of the steam cars, the general design was the same in all, the boiler being forward and the water-tank behind. The details varied greatly, vertical water-tube, vertical fire-tube, locomotive, and flash boilers all being in use. The steam engines were generally of the two-cylinder compound type, with provision for the use of high-pressure steam in both cylinders for starting or overcoming heavy resistance. Single-acting high-pressure engines were also employed in connection with flash boilers. All vehicles were fitted with change gears, giving two changes, these being engaged either by sliding the teeth in and out of mesh, or by the use clutches; it being necessary to shut off steam while changing gear.

Freedom of action between the sprung and unsprung portions of the gear is obtained either by chain connection or by universal joints; the differential gear in all cases being arranged so as to be readily locked. With but one exception the Ackermann steering method was employed, this machine having also no differential gear, but using a separate engine for driving each

rear wheel. An independent reserve method of feeding the boiler appeared in each case, and condensers were not found on any of the competing vehicles.

"Throughout these steam wagons, one cannot but be struck by the enormous improvements which have been made both in their construction and in their capabilities; the majority of them bear ample evidence to the fact that heavy road vehicles have now been brought to a stage at which they are entirely suited for continuous and reliable duty under any of the usual working conditions, and at which minor improvements only may be expected in the future. In the matter of serious vibration, even when travelling over the worst roads, all the cars were remarkably free from this; even fragile goods could evidently be carried without fear of breakage, if they were packed with reasonable care."

The report, although only that of the publication referred to, and to be supplemented by the official report of the judges, shows that the requirements were by no means too difficult of accomplishment, the details of the various trials showing the success with which they were met. Awards were made to all the vehicles in all classes except class D, which was held under advisement.

The Properties of Steel Castings.

AMONG the papers recently read before the Iron and Steel Institute was one by Professor J. O. Arnold, upon the results of experiment on the properties of steel castings, these experiments having been commenced about six years ago. These experiments were undertaken to determine a number of important points, such as the influence of chemical composition, of annealing, of variations in specific gravity, of heat treatment, etc.

It is impossible in this place to give a full abstract of this important series of researches, but some general idea can be given of their scope and the nature of the results, referring the interested reader to the original paper for full details.

The specimens were made to conform as nearly as possible to the specifications at present issued by engineers for high-class material, and as far as chemical composition was concerned they were grouped according to character as: nearly pure iron and carbon castings; iron, carbon, and silicon castings; and iron, carbon, and manganese castings. These were cast in test pieces in such a form that four test bars were obtained from each feeder, two being tested as cast, and two being annealed, in each case.

The effects of annealing are very clearly shown in the numerous reproductions of etched sections, the methods of metallography being most successfully applied to make the physical constitution of the specimens visible. The method of annealing was very thorough when it is remembered that the test specimens were only 0.25 square inch area and 2 inches long. The pieces were annealed in covered cast-iron boxes, filled with lime and maintained at a temperature of 950 C. for about 70 hours. This was followed by about 100 hours of cooling, after which the pieces were drawn. While this drastic treatment was hardly necessary for such small pieces it must be considered that in practice the juxtaposition of light and heavy masses requires prolonged soaking, not for hours but for days, in order to bring all parts to a common temperature.

The most important result of the tests was the demonstration of the unsuitability of pure iron and carbon steel as a material for the fulfillment of the modern specifications by engineers for steel castings. Ductility can be secured with ease, but without the required tenacity; while if tenacity is obtained it is at the expense of ductility. Thus far the results of the tests have been of a negative interest, but this may prove of a decidedly positive value as showing the necessity of employing some other composition.

The trials upon the influence of silicon and of manganese, which are yet to be made, will doubtless prove of more positive interest, and the whole series, when completed will add much to our store of knowledge of this most important branch of the materials of construction.

Merchant Vessels as Naval Auxiliaries.

IN view of the recent employment of vessels of the American line as naval auxiliaries during the Spanish-American war, the paper of Lord Brassey before the Institution of Naval Architects is important and interesting.

The history of the question was briefly traced in the paper, the earliest contracts for the conveyance of the mails providing that postal vessels should be suitable for conversion into armed cruisers. Sir Nathaniel Barnaby urged the subject in 1877, and his views met with hearty support, while Admiral Fournier emphatically stated that the great transatlantic liners were destined to be the commerce destroyers of the future.

Passing on to the later authorities the practicability of so constructing merchant steamers as to render them readily available for war purposes was discussed by Mr. Biles in a paper read at an engineering conference, held under the auspices of the Institution of Civil Engineers in June, 1899. Arguing from the results of arming and fighting the mercantile cruisers of the United States Navy, Mr. Biles takes the view that such vessels are not unable to cope with thoroughbred warships. The experiences of modern sea fights point to the conclusion that a ship is more liable to be disabled by her crew being driven from their guns than to be sunk by the effects of shell-fire. The issue of a fight between a warship and a merchant ship may not turn on the relative efficiency of the internal subdivision, but on the protection of the guns. By placing the guns in a box battery, as the Americans did, a considerable number of guns could be as well protected in merchant ships as in first-class cruisers. Mr. Biles holds it to be practicable, with due consideration in the early stages of design and construction, to so protect machinery and armament that the merchant ship need not be much, if at all, inferior to many warships.

"The policy of liberal subsidies to the Mercantile Marine has given to the merchant navies of foreign Powers a decided advantage in the possession of the types of vessels most suitable for naval purposes. The Germans have taken the lead. They have two ships now running—the Deutschland and the Kaiser Wilhelm, of 14,000 tons and 15,000 tons respectively—which exceed in speed by nearly two knots our best ships. No vessel now building for the British flag will rival in speed the Kaiser Wilhelm II. and Kronprinz Wilhelm under construction in Germany."

Lord Brassey calls attention to the fact that notwithstanding Great Britain equals the combined merchant navies of the world in actual tonnage fewer than one-half of the 157 ships of 16 knots and over are under the British flag. Out of the £2,000,000 which Parliament has been asked to vote for the navy only £63,000 is payable to the owners of reserve merchant cruisers, in spite of the disproportion above shown. It is the fixed resolve of the people, and, perhaps the first duty of British statesmen, to keep the Empire secure from attack, and to give protection to the commerce on which our existence depends. In pursuance of this policy we have more than doubled the expenditure under Navy Estimates, and still we seem to fall short of the full requirements for the naval defence of the Empire. It would be impossible to fix a limit to the number of cruisers required for the protection of a commerce which extends over every sea. The construction of cruisers has absorbed in recent years a large proportion of the shipbuilding votes. But when the cost of the first-class types falls little short of that of the battleship, the numbers we can build are all too few for the work they might be required to do. We cannot cut down the expenditure on battleships.

"If, therefore, our regular-built cruisers are fewer than we could wish, we must look to our Mercantile Marine, and, out of the abundant materials we there find ready to our hands, we may organise a supplemental fleet of armed cruisers such as no other State can furnish. The Admiralty should utilise these resources by liberal subsidies. The standard of requirements should be high. The speed should not be less than that of the Deutschland—let us say, 22 knots at sea. Mercantile auxiliaries should be protected by a deck or belt of Harveyised armour—the necessary armaments should be in readiness. Calculations of cost can hardly be attempted in a paper in which nothing more is attempted beyond suggesting a policy."

It can however be shown that for a first-class cruiser, in addition to the cost of maintenance, the interest, depreciation, and insurance will reach £70,000 a year, while a mercantile cruiser can be retained at a cost of only about £10,000 a year.

"We must further take into view the economy resulting from the maintenance of

the mercantile auxiliary by the ship-owners, as against the maintenance of the man-of-war in our Royal yards. In conclusion, I claim that it has been clearly shown that we can have many auxiliaries for the cost of one cruiser; and these auxiliaries may have effective protection. If not equal to the ship of war as combatants, they will be superior in coal endurance and probably in speed for long distances. They would be the scouts of our fighting squadrons. They would protect our commerce from interruption by the auxiliary vessels of a hostile Power."

Coal Cutting by Machinery.

At the conclusion of a series of articles on coal-cutting by machinery, which has been running for some time in the *Colliery Guardian*, some points bearing emphatically upon the colliery practice of Great Britain are made which will bear noticing here.

In the first place the whole of the coal in the United Kingdom must be cut by machinery if foreign competition is to be met. The parallel is drawn between coal production and corn production, and the manner in which American agricultural machinery caused English wheat to be a thing of the past is cited as a warning.

Usually much difficulty is met in attempting to introduce improved machinery into collieries. It is thought out of all reason to alter any of the arrangements of the colliery to give a new invention a chance, no matter what the ultimate advantages might be. If the English coal industry is not to go the way of the English wheat industry this attitude must be changed.

"The inventor must have reasonable facilities, and collieries must either go to the inventor, or work out the problems themselves. The latter would be the very best solution of the problem, if each colliery manager set himself seriously to do all his work by machinery, to introduce machinery everywhere, remembering that every machine does two things, if it is a proper machine, viz., it renders the manager independent of men to the extent of the number of men the machine displaces, and it is something done to enable the industry to compete with the coming American invasion. For the American invasion will come, as it has in other industries."

A natural result of the treatment which engineers meet in endeavoring to introduce improvements into the colliery is seen in the reluctance of manufacturing electrical firms to undertake colliery work, especially as they are able to obtain plenty of work in directions in which they are welcomed. The suicidal result of this policy is evident.

"The American invasion may be taken as a foregone conclusion. The course which has been adopted in the case of every other industry is being adopted in the case of coal. First, the English product is bought largely, then the machinery by which the English product is made is bought largely and the men who have been engaged in making it, then the English product is barred out by a tariff, which is gradually increased while the home trade is built up; then as the output is increased it gradually overtakes the demand, and the surplus is promptly shipped off to Europe, or wherever else it can be got rid of and sold for whatever it will fetch. By this last a foreign trade is built up, and by then the introduction of machinery has brought down the cost of production and transport to below that of all but specially favoured cases."

The Economical Speed of Ships.

Among the papers presented before the recent meeting of the Institution of Naval Engineers that of Mr. E. Tennyson d'Eyncourt upon the limits of economical speed of ships present features of much value.

It has, perhaps, been too common a practice in fixing the speed for a vessel, and in estimating the necessary indicated horse-power for that speed, to overlook the question of what speed is appropriate to the form of vessel under consideration, and to go upon the broad basis of allowing plenty of margin of horse-power, with the result that often too high a speed has been aimed at, and too much power has been allowed. As a necessary consequence, the weight and cost of the excess has been a continual burden upon the earning capacity of the ship. This was, perhaps, very well when competition was not so keen, but nowadays, when cost has to be cut down to a minimum in every direction, not only by the shipbuilder, but also by the ship-owner, the question of giving a ship enough, and not too much, power and speed has become one of first importance.

It is necessary to bear in mind the fact that every ship has an appropriate limit of speed, beyond which it is most uneconomical to attempt to drive her; or, in other words, any increase of speed beyond this limit requires an undue increase of power. It has therefore been the object to arrive at a method of defining this limiting speed for ships of different sizes and different forms.

A general solution of the problem is almost an impossibility, but by a careful analysis of the performances of different vessels some fairly comparative results may be obtained. Computing the resistance due to skin friction, according to Froude's method, and deducting this from the effective horse power at any speed gives the power necessary to overcome the so-called residuary resistance, which at the higher speeds is principally caused by wave making.

The ratio of wave horse-power to skin horse-power at the limiting speed depends, of course, upon the form of entrance and run and the mean girth of the vessel up to the water line; but ½ seems to be a fair average value for vessels of fine entrance and run and full midship section. If the midship section is fined, and the wetted surface thereby reduced for the same block co-efficient, it naturally follows that the entrance, or run, or both, must be filled out, with the effect that the skin resistance is reduced, and the wave-making increased, bringing the curves of skin horse-power and wave horse-power more closely together, as indicated by the dotted curves on the diagram, and bringing the point where skin horse-power is equal to wave horse-power to a lower speed.

It is therefore impossible to lay down general rules to meet all cases, as the variations which may occur are almost infinite in number, and so only an indication of the kind of thing that may be expected can be given. Considerations of stability, involving beam, or fulness of water line, or of girth, which affects weight of hull, more especially if the vessel is to be built to Lloyd's rules, or the question of docking facilities, are merely examples of what the designer has to take account of, and they often hamper him in adopting what he knows would be a better form, or more suitable dimensions for the speed than those he is compelled to take.

The skin horse-power varies as the 2.83 power of the speed, but the wave horse-power varies as the 7th power at the limiting speed and as high as the 10th power at 12 per cent. above the limiting speed.

Plotting the various results as curves corresponding values for C the constant in the admiralty formula:

$$C = \frac{D^{\frac{2}{3}} v^3}{I.H.P.}$$

are deduced as follows:

Length of Ship on Water Line. Ft.	Value of C at Limiting Speed.	Value of C when Skin H.-P.=Wave H.-P.
200	225	188
300	256	207
400	278	224
500	295	237
600	310	246

These values of C are less for the smaller ships, on account of the higher coefficient of friction for the shorter length of vessel, and also on account of the error in the assumption of the general truth of the law of comparison when applied to the whole resistance. These two causes are not, however, sufficient of themselves to account for the decrease in the value of C. I think this decrease is partly due to eddy-making, caused by minor projections and irregularities in the surface of the smaller ships, these irregularities being on a proportionately larger scale in the smaller than in the larger vessel. It must also be borne in mind that any roughness of sea or wind has a greater effect in proportion on the smaller ships, tending to spoil their performances on trial, as compared with those of larger ships.

It has been found that the indicated horse-power is usually increasing as the 7th power of the speed when the skin horse-power, is equal to the wave horse-power, or at about 12 per cent. above the limiting speed.

"This is then the speed at which it becomes economical to increase all the dimensions of the ship in the same proportion; of course, from the point of view of driving the greatest displacement at the given speed.

"There are many vessels in which this limiting speed is far exceeded, such as fast cross-channel passenger vessels, torpedo gunboats and destroyers; but these types

are for very special requirements, and are not economical in the sense of carrying large displacement at the required speed. They are not, therefore, included in the scope of this paper. Nor do the figures given apply to vessels of very great beam in proportion to their length. The examples taken are all of ordinary proportions, not less than 6½ beams in length, and of ordinary draughts; but, as this includes practically all mercantile vessels, and also cruisers of the usual dimensions, the range is fairly wide.

Naval Boilers.

PRESIDENT LINCOLN is credited with the homely saying, when urged to make an important change in time of emergency, that "It is a bad plan to swap horses when crossing a stream." The same maxim might be applied to the action of the admiralty in the matter of the naval boilers.

An editorial in a recent issue of the *Engineer* contains some timely words in this matter, calling attention to the imminent fact that the whole shipbuilding programme remains chaotic and disorganized because no one knows what boilers are to be put into the warships. The cylindrical boiler has been abandoned and water-tube boilers have been determined upon. The Belleville boiler has been condemned by the interim report of the Admiralty Commission and no other boiler has been definitely adopted. In the meantime competitive trials are made between the Hyacinth and the Minerva, both of which vessels are equipped with the identical types of boilers which have been condemned as unfit for naval use. What earthly use such trials can be remains to be discovered.

There seems to be a serious impression existing that nothing but a large-tube boiler will do for naval service, notwithstanding the fact that the only boilers which have been continuously satisfactory are of the small-tube express type. All the large-tube boilers have given difficulty with the bending of the tubes, and this appears to have little or nothing to do with the detailed construction, and is apparently inherent in the type. Further experience is called for to discover the cause of this and other difficulties, but in the meantime there is nothing whatever to prevent the equipment of one or more vessels with small-tube boilers of the Yarrow and Thornycroft type. There is nothing now experimental about these boilers, and they have been successful under the most trying conditions. To put such boilers at once into the vessels now in uncertainty could do no harm, and would indeed effect much good. Such action could make no delay in the investigations which are under way concerning the boilers which it has been decided to abandon, nor would it prevent the discovery of the defects in those which it is suggested to adopt. In the meantime work on important warships would not be needlessly delayed, and confidence, now sadly strained, would be restored. The whole story is summed up in these few words: "The express boiler is, on the whole, able to comply with all the requirements of a ship of war. No other type of water-tube boiler has established a reputation for itself anything like this, while several are absolute failures, or unsuitable for naval purposes."

If it is desired to adopt the combination of cylindrical and water-tube boilers, the small-tube boiler appears eminently adapted to act as a prompt reserve for the tank boiler, and this arrangement might be worth trying. In any case, however, let the present uncertainty be terminated, and let the vessels now under construction be equipped with boilers about which everything is known, and let the long-drawn-out experimenting with uncertain types be continued with something less important than the navy upon which the fighting strength of the empire depends.

REVIEW OF THE CONTINENTAL PRESS

The Power of the Upper Rhone.

THE extent to which Switzerland has utilized the water power of her glacier-fed streams has caused longing eyes to be directed towards these valuable natural resources from other directions. France, especially, sees in the Alps of Savoy a valuable source of motive power, and the use which Switzerland has already made of the Rhone has caused important plans to be made regarding the utilization of the power of the same river after it has entered French territory.

In a paper recently presented before the Société des Ingenieurs Civils de France, and published in the *Mémoires* of that society, M. A. Garcia gives an exhaustive study of the utilization of the falls of the Rhone from the Swiss frontier as far as Pyrmont, a distance of about 27 kilometres (less than 17 miles).

This portion of the Rhone is not navigable, even for small boats, but traverses a rough country between rocky banks occasionally more than 100 metres in height, while at one point, about 600 metres above Bellegarde, the stream is precipitated from a height of 13 metres into an underground bed where it is lost to view for a space of 200 metres. There is, therefore, no useful purpose to which this part of the river can be applied other than the production of motive power, and it is to the best utilization of this power that M. Garcia devotes his discussion.

Instead of permitting the water power to be improved by disconnected plants, under private enterprises, he advocates the preparation of a complete scheme for the best development of the natural power available, believing the importance of the subject such as to render it worthy of government supervision and concession. The mean total power available in the portion of the Rhone from the Swiss frontier to Pyrmont is estimated at more than 160,000 horse power. The flow of the river is very variable, ranging, according to the long-continued observations of the official service at Geneva, from 57 cubic metres per second for very exceptional low water, to 1,230 cubic metres at the extreme, and equally exceptional floods. The ordinary variations range from a low water flow of 170 cubic metres to a flood delivery of 900 metres, there being a fairly constant flow of 200 cubic metres per second for a period of about 325 days in the year. The very low water occurs in winter, while the floods, due to the melting of the snows, are in June, July, and August.

The power company at Bellegarde already has the concession for 60 cubic metres per second, and is desirous of obtaining the right for the entire flow of the river, while at the same time three other projects are under consideration for the establishment of power stations at other points on the stream. The fall at Bellegarde being 13 metres, a flow of 60 cubic metres should give a gross power of 10,400 h. p., while in fact the plant now in operation utilizes but 4,000 h. p. The proposed plants would be situated at Pont de Grésin, about 11 kilometres from the Swiss frontier, where a dam would permit a maximum of 34,000 h. p. to be obtained; at the Boucle du Rhone, where a tunnel of 1,370 metres long across the bend of the river above and below Bellegarde would enable the utilization of more than 50,000 h. p.; and, finally, by the proposed plant at Malperthuis, where a similar tunnel across a loop in the stream would permit about 32,000 h. p. to be developed.

The details of the cost of installing these various plants are examined by M. Garcia, with the result of an estimated cost of 260 francs invested capital per horse power, while if the plans for the Pont de Grésin and the Boucle du Rhone are united, by the construction of a combined canal and tunnel this cost would be reduced to 183 francs per horse power, for installation charges.

M. Garcia, however, advocates an entirely new scheme, to replace those already under consideration. Having made a careful study of the cost and advantages of the successive utilization of portions of the stream, he proposes a channel extending directly from a point above the Pont de Grésin to Monthoux, this cutting across the long bend in the river upon which all four of the plans already referred to would be situated, and giving one fall of 57.50 metres for 200 cubic metres of water per second, corresponding to 153,300 h. p. Between Monthoux and Pyrmont there is sufficient if all to make it practicable, by the construction of a dam, to utilize 16,000 more h. p., giving a total of 169,300 h. p.

The general arrangement of the proposed plans will best be understood by an examination of the map upon which only the points directly involved in the proposed schemes are indicated.

The chief objection to the plan of M. Garcia, besides that of the rights of the existing company, is the length of the canal required for the delivery of the water across the bend of the river. The total distance is 10,700 metres (6.64 miles) of which 4,600 metres would be tunnel (2.86 miles). The cost of this plan, entire, is estimated at 24,300,000 francs, or for 153,000 h. p., 158 francs per horse power.

In urging the adoption of a single complete plan for the development of the hydraulic power of the upper Rhone in France, M. Garcia makes some interesting observations upon the growing importance of water power in connection with electric transmission.

When we consider establishments operating continuously with large power, the steam engine cannot possibly compete with water power. The development of large hydro-electric stations must work a complete revolution in such industries as demand much power, such as electro-chemical and electro-metallurgical establishments, given ample power at moderate cost, and it it difficult to predict the limits of electro-chemistry. The possibility of fixing the nitrogen of the air by electrical action would make it practicable to replace the enormous quantities of nitrate of soda and sulphate of ammonia now used as fertilizers, and water alone would be necessary for the requirements of agriculture. Electric traction, deriving its source of power from the hydraulic energy of mountain streams, has already been developed in mountainous countries, and in Italy and Switzerland may be seen the results of this influence.

The most important effect, however, is to be looked for in the transmission of electric energy to the vicinity of the power stations, building up industrial centres otherwise impracticable. In this connection it is interesting to note that the advantages of electric power in local distribution appear in a marked degree when steam is replaced by electricity. A manufacturer, using 50 h. p. from a steam plant, for instance, in replacing it with electric power arranges for an equal amount, but finds in practice, that he uses but 35 h. p. to accomplish the same work, the difference representing the amount formerly lost in transmission and distribution by the wasteful employment of shafting, belting and hope transmission.

Certain it is, that in these days of rising coal prices, and closer manufacturing economies the owner of mountain streams, derived from the never-ending supplies of white coal, can no longer be neglected by those countries so fortunate as to possess such stores, and the location of the industrial centres of the coming generation may be greatly affected by considerations hitherto almost neglected.

Progress in Aluminothermy.

We have already noticed in these columns the process of Dr. Hans Goldschmidt for producing very high temperatures by the combustion of aluminum alloys. At the recent meeting of the *Verein Deutscher Eisenhuttenleute* Dr. Goldschmidt delivered an interesting address, accompanied by experimental demonstrations, showing the recent extensive developments of the process and from the report of the address in *Stahl und Eisen* we make some abstracts.

Prominent among the applications of thermite, as the Goldschmidt alloy is called, may be noted the reduction of such metals as chromium and manganese without the presence of carbon. This reduction is effected in large crucibles, holding several centners of metal, and the operation is rapid, requiring scarcely more than half-an-hour for a charge. The resulting chromium, being entirely free from carbon, is especially valuable in the manufacture of chrome steel, while the manganese produced in a similar manner is used for making manganese bronze. Chromium prepared in the ordinary manner contains 10 to 12 per cent. of carbon, and its addition to steel materially modifies the carbon content.

This pure chrome is also useful in preparing other alloys, while pure titanium may be made and used in a similar manner.

Various useful alloys may be made with pure manganese, the absence of iron and carbon being especially important, and there is every reason to believe that the commercial production of these metals in a pure state by the Goldschmidt process will open up some valuable alloys hitherto not obtainable.

Both nickel and cobalt may be reduced by combustion of aluminum, and while the cost of cobalt renders it unavailable the production of pure nickel is most desirable. In like manner we may reduce boron, vanadium, etc., and an entire new field of metallizing is opened by this possibility of working with a metallic fuel producing a remarkably high temperature.

The practical uses of thermite as a means of melting or welding have become more and more extensive. By the use of special clamps and devices a number of operations, otherwise difficult, are readily performed, and as a means of repairing broken or defective parts, the use of thermite bids fair to become generally employed. By the use of a convenient and portable jacket and clamp, it is possible to weld the joints of pipes for gas, water, or steam, after the pipes have been placed in position, the joints in such cases being as strong under test as the other portions of the pipe. The advantages which the possession of such a material gives the engineer, far removed from supplies and repair shops, as at sea, can hardly be enumerated.

The employment of thermite for welding the ends of rails, has already been discussed. The value of continuous rails for the prevention of stray currents and consequent electrolysis of water and gas pipes is again emphasized by Dr. Goldschmidt. Not only for electric tramways, but also for the rails of main line railways. In the case of tramways the rails are imbedded in the earth to an extent which prevents great and sudden changes in temperature, and hence it has been found practicable to weld long lengths of rail, with but few breakages from expansion or contraction. On main lines, however, the rails are exposed to atmospheric changes of temperature, but in spite of this it has been found practicable to join several lengths of rail by welding and thus materially reduce the number of open joints. In tunnels, where the temperature is practically constant and where the elimination of joints is an especial advantage, the length which may be continuously welded is much greater.

Dr. Goldschmidt describes a number of instances in which the use of thermite for repairing broken pieces has been successful and advantageous. New journals have been welded to heavy rolls, broken pump-rods have been joined, and a number of structural combinations successfully united by means of this convenient application of intense local heating.

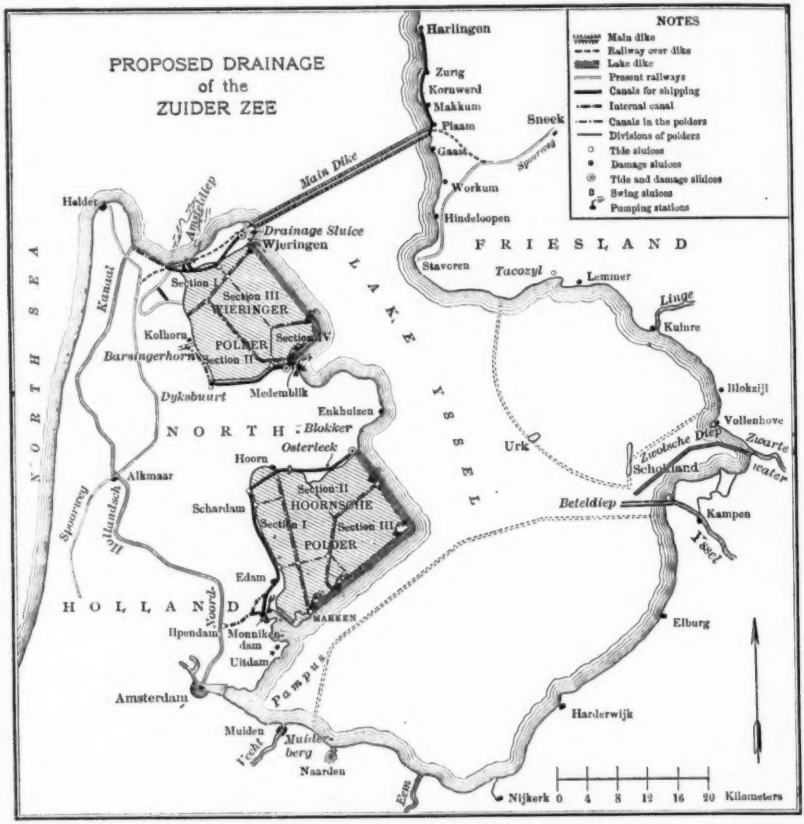
It is not to be expected that such an expensive combustible can be used in ordinary cases, but for special work, and for use in emergencies thermite offers many possibilities.

It is interesting to note that, as aluminum is now practically all produced electrolytically, the heat derived from its combustion may have its origin traced to the source of energy from which the electric current was

produced, either water or steam power, and hence aluminothermy, as it has been termed, is practically an application, after several transformations, either of the heat of the sun, by which the water of Niagara, for example, was raised, or of the fuel burned under the boilers of some generating station.

In a recent number of *De Ingenieur* is given a description of the present project, which while less ambitious than the original one of Van Diggelen, seems far more probable of successful execution.

These plans are based upon those of Beijerinck, who, in 1866, proposed to cut off the Zuider Zee from the North Sea by a



The Reclamation of the Zuider Zee.

For a long time the idea of draining the body of water known as the Zuider Zee has been discussed in Holland, the plans of Van Diggelen having been proposed in 1849. These plans included the enclosure and reclamation of the whole of the area of the Zuider Zee within the north Sea Islands, but the magnitude and cost of the project proved too great an obstacle to its serious consideration.

dike, and to drain a portion of the land, and these plans, further developed by Stieltjes, were taken up by the Zuiderzeevereeniging, which body, since 1886, has been actively engaged in making surveys, and overcoming political opposition.

Briefly, the scheme now practically adopted consists in the construction of a dike across the mouth of the Zuider Zee from Wieringen to a point on the coast of Friesland, near Piaam. This encloses the inland

waters of the Zuider Zee from the North Sea and at once reduces the length of coast line requiring protection from 320 to 40 kilometres, so that an immediate economy in coast protection is at once secured. A railway line will also be run across the top of the dike, thus shortening the communication between North Holland and Friesland.

The portion of the Zuider Zee enclosed by this dike will then be partially reclaimed, and partly converted into a fresh water lake. In order to avoid the delay in utilizing the reclaimed land the work is to be divided into sections, these being enclosed and drained successively, instead of attempting to do the work all at once.

The first portions to be reclaimed are the Wieringer polder, a section enclosed by a dike extending from Medemblik to Wierigen, and the Hoornsche polder, a similar area south of peninsula of North Holland. For later drainage there are reserved two much larger areas shown by the dotted lines on the map, these not being at present included in the immediate scheme.

The undrained space will form a lake, which being supplied by the river Yssel, will be known as Lake Yssel, and this will furnish a much needed fresh water supply to Friesland, and also avoid closing the water communication between Amsterdam and a number of towns now upon the Zuider Zee.

Apart from the engineering difficulties the questions of finance have been important, as it has been difficult to show a profit to independent undertakers for the scheme. The present plan, however, provides government backing for the company, this being warranted by the great gain to the State by the addition of such an area of new territory.

The estimates of cost include a total for the construction and protection of the great dike of 57,100,000 gulden, of which 4,500,000 gulden is for the compensation of the fisheries, and 8,000,000 gulden for defensive works. The cost of drainage is estimated at 12,700,000 gulden for the Wieringer polder and 22,850,000 gulden for the Hoorn polder, to which must be added 2,000,000 more for defense, or a grand total of 94,650,000 gulden, (about £7,800,000 or $38,000,000). The return for this expenditure will be the reclamation of 53,220 hectares of land, of which it is estimated that 46,250 hectares (about 115,000 acres) will be fully available for cultivation.

The necessary funds for the work are to be obtained from a loan running for 60 years, while the reclamation works are expected to be completed in eighteen years. The cost of draining the two larger polders is estimated at 85,000,000 gulden for the south-east polder and 50,500,000 gulden for the northeast polder; the respective areas being rather more than 100,000 hectares and 50,000 hectares, (247,000 acres, and 123,000 acres). These latter works, however, are not under immediate consideration, but naturally have been considered as an ultimate portion of the whole project which will begin with the construction of the main dike across the entrance of the Zuider Zee.

While the expense of this great work runs well up into the millions it may be regarded as money well spent, since it adds to a land, much of which has already been won from the sea, a large additional tract for a permanent possession. When we consider what enormous sums have been expended by nations without a murmur for the purpose of wresting territory from others by force of arms, we may well applaud a project which wages war for land with the ocean alone. In this respect Holland well deserves the consideration of statesmen who have yet to learn that among the weapons which are mightier than the sword may be included the spade of the engineer and the hammer of the mechanic.

Coal Handling at Rotterdam.

THE port of Rotterdam is the natural outlet of the Rhenish-Westphalian coal district, not only because it is the nearest harbour, but also because of the excellent water communication afforded by the Aermel canal. The constantly increasing coal trade of the port, therefore, has made increasing demands upon the capacity of the coal-handling facilities, especially in connection with the coaling of steamers and the loading of colliers. In 1887 a 10 ton Armstrong hydraulic coal tipple was installed, followed by a similar one of 15 tons capacity and greater speed, by the same makers.

These two machines served the purpose of the harbour up to 1898, when the demands

became too great for them. Already in 1893 the shipments of coal reached 114,000 tons for the year, while in 1896 the capacity reached 214,000 tons, and the machines were being operated to their extreme limit. In providing for the increased demand it was decided to adopt electric driving, and in recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* is given a fully illustrated account of the new electric coal handling plant, now in active operation.

The new electric tipple was required to be of the same capacity as the second Armstrong machine, but the framework was made much stiffer and stronger. The operating machinery is enclosed entirely in the adjoining buildings, and each function is actuated by an independent electric motor. By thus placing the electric machinery in an enclosed space much greater care can be given to its protection, both from dust and from the moisture of the climate of Rotterdam.

The general construction of the machine is that of a pyramidal tower of structural shapes, forming guides and supports for a lift platform in which the wagon containing the coal is raised and tipped so that the entire contents are delivered into a chute leading to the hold of the vessel beside. This tower is about 75 feet in height, strongly braced, the top containing supports for the cable sheaves which serve to raise and tip the platform, the wire cables running from thence to the electrically driven windlasses below. In addition to the platform, there is mounted upon the upper part of the tower a derrick crane carrying a coal bucket, this being used to deliver the first portion of coal to the hold of an empty vessel, in order to provide protection against the force of the coal dropping from the main chute.

The work of the machine requires six independent windlasses, as follows: (1) hoisting and lowering the car platform; (2) tipping the car into the chute; (3) raising and lowering the chute; (4) changing the inclination of chute; (5) hoisting and lowering the crane bucket; and (6) swinging the crane boom.

The total weight to be handled on the platform, including its own weight and that of a loaded car, is 44 tons, partly counterbalanced, which is handled at a velocity of 0.33 metres per second. For this work an electric motor of 130 h. p. is provided, operating a windlass provided with double-spiral drum, from which wire cables are led to the top of the tower. A 60 h. p. motor is provided for the tipping of the platform, while a motor of 17 h. p. is arranged to be connected either with the windlass for hoisting the chute, or with that for varying its inclination.

The whole of the operating mechanism of the tipple is controlled from a small cabin, placed upon the top of the tower, where all the conditions can readily be seen. The operator stands between the controlling levers, one of which sets in motion the hoisting and lowering mechanism of the platform, and the other controls the tipping. The adjustment of the chute is regulated separately, this only being changed at considerable intervals.

The coal car is drawn upon the platform by an electric windlass, bolted fast, hoisted, tipped, lowered, and drawn away, these functions being controlled by three men, one in the cabin above, and two below.

In 1898 there was handled at the port of Rotterdam 350,000 tons of coal, but in 1899 this fell to about 260,000 tons, and with the present facilities the demands can probably be met for some time.

The advantages of electric power in such work are plainly shown in this interesting installation, the ability to remove the operative machinery to a place of shelter and protection, and at the same time permit the operator to be placed in full view of the work, with command of all the controlling mechanism, being a most valuable feature.

The Incandescent Gas Burner.

WHEN the introduction of the electric light gave a powerful competitor to gas lighting, the first attempts to meet the rival were based upon methods of giving a higher illuminating power to the gas flame itself. These consisted mainly in enriching the gas by suitable carburetting, and also, as in the Siemens regenerative burner, by greatly increasing the temperature of the combustion.

About 1885, however, the researches of Dr. Auer showed that great progress might be made along a new line, namely that of providing some other incandescent material

besides the carbon contained in the gas itself, and the result was the well-known Auer, or Welsbach, incandescent mantle. In view of the progress which this form of gas light has made, the paper recently prepared by Herr Franz Bössner, and published in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines,* upon the theory of the incandescent gas light is of importance.

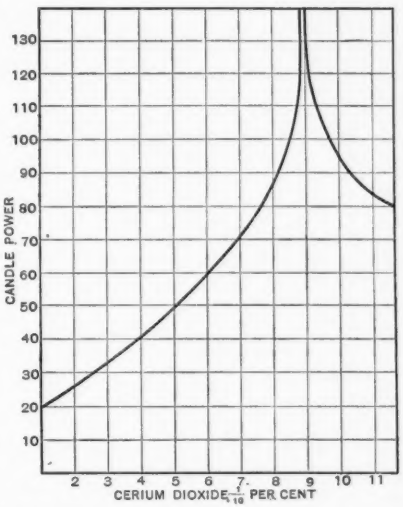
The use of solid incandescent materials for the production of light from heat originated long before the experiments of Auer, but with him began the practical use of the oxides of the so-called rare metals of the earth. The early mixtures employed consisted of varying proportions of oxides of lanthanum and yttrium, together with magnesia or zirconia, there being generally 60 per cent. of magnesia or zirconia with 20 per cent. each of the rarer oxides. Besides the above materials the oxides of thorium and cerium have been employed, and in the later incandescent mantles these latter oxides are used almost exclusively.

According to the investigations of McKean the following illuminating values are obtained for the various oxides, with a consumption of three cubic feet of gas per hour under a water pressure of one inch:

	Candles.	Color.
Oxide of Thorium	3.56....	Blue-white.
Oxide of Lanthanum	28.32....	White.
Oxide of Yttrium	22.96....	Yellow-white.
Oxide of Zirconium	5.36....	White.
Oxide of Cerium	5.02....	Reddish.

Under these circumstances it is not surprising that the first attempts at the construction of an incandescent mantle should have been made with materials showing such high illuminating power as the oxides of lanthanum and yttrium. Experience, however, has shown that materials which emit but little light singly may become brilliantly incandescent when heated together. Thus thorium and cerium are among the lowest in the above table, and yet analysis of the most brilliant mantles made under the later Auer patents of 1893, shows the composition to be about 99 per cent. of oxide of thorium and 1 per cent. of oxide of cerium.

In studying the theory of this action several points are to be considered. Does the emission of light consist as a peculiar property of a material, or mixture of materials? Or, does it consist in a capacity for internal molecular motion, by which latent energy is released to appear in the form of light? Certain analogies in acoustics may here be noted. The flame of the Bunsen burner may be likened to a certain note, the vibrations of which correspond to those of but a single tuning fork capable of vibrating in unison with it. In like manner the slight admixture of oxide of cerium may act to bring the oxide of thorium into synchronism, so to speak, with the vibrations due to



the temperature, so as to permit the conversion of the greater part into light.

The catalytic action of certain substances, by which they facilitate the combination between other bodies without undergoing any permanent change themselves, is well known. Thus there may be, according to Hehner, a continual dissociation and recombination of the two oxides, but this view does not appear to be confirmed by the experiments of Bunte. These latter experiments, in which the various compounds used in incandescent mantles were exposed to the heat of the electric current, appeared to show that the action of the oxide of cerium acted to separate the particles of oxide of thorium and permit the latter to be raised to a high degree of incandescence, just as a very fine platinum wire is raised to a white

heat in a flame which will bring a heavier wire merely to a dull red.

The experiments of Le Chatelier and Boudouard show the material used in the Auer mantle to be feeble in emitting heat rays, while the Bunsen burner, on the contrary, emits much heat and little or no light. The Bunsen flame and Auer mantle are rich in yellow, green, and blue, but very weak in the red rays and in the infra-red rays of the dark spectrum, and since the red rays represent a large proportion of the energy, this may have an important bearing upon the theory of the incandescent mantle.

The diagram, after the experiments of Dr. Drossbach, shows the influence of varying percentages of oxide of cerium upon the luminosity of the mantle. The horizontal abscissas represent tenths of a per cent. of cerium di-oxide to thorium oxide in the mantle, and the vertical ordinates represent the corresponding candle power.

The Heating of Railway Carriages.

SINCE the exposition of 1889 there has been great progress in the improvement of railway material, and a comparison between the exhibits of that exposition and the one recently closed at Paris, shows very clearly the progress which has been made. Among the various elements which go to make up the comfort of the traveller by railway, no one is more important than that of proper warming, and this subject is very fully treated in a series of papers recently published in *Le Génie Civil*, prepared by M. H. Guérin, the engineer in charge of the department of lighting and heating of the Northern Railway of France.

Of modern systems, three distinct kinds may be mentioned—hot-water, steam, and electricity.

Hot-water heating, as employed on the Northern Railway of France, is accomplished by what is termed the "thermo-siphon" system. This is very similar to the apparatus used for hot-water house-heating, modified by the peculiar conditions existing in railway service.

The boiler, with central cylinder for the fuel, and either spiral or annular water space, is placed underneath the carriage near one side, and the water circulates through flat radiators placed in the floor of each compartment, an expansion tank being placed in the upper part of the carriage above the boiler. The boiler can be fed from without, when the train is at rest, when the ashes can also be shaken down through the grate. The fuel at first used was gas coke, but this has since been replaced by anthracite, with improved results.

Heating by steam has been employed in Germany, Austro-Hungary, and Switzerland, radiators being placed under the seats, and so arranged as to permit a circulation of air, this being an important difference over the hot-water system, which mainly provides warm places for the feet, and considers the general heating of the air as a secondary matter. The steam is taken from the boiler of the locomotive, the pressure being controlled by reducing valves, and steam traps being employed to remove the water of condensation.

The so-called "mixed" systems are interesting, water and steam being used in connection. Thus, in the Körting system, used in the sleeping cars of the Compagnie des Wagons-Lits, the water is made to circulate through the system by the propulsive force of a Körting injector, the steam at the same time being condensed and thus heating the water. This gives the advantages of hot-water heating without the inconvenience of separate boilers, the steam for the injectors being taken from the locomotive boiler.

On the Eastern Railway of France the Lancrenon system, employing steam and compressed air, is used. The air, not condensing, maintains a circulation and carries the water of condensation along with it, while the temperature cannot fall below that of saturated steam at the pressure of the mixture. Another plan is adopted on the Paris, Lyons, and Mediterranean Railway; heaters containing water being placed in the floor of each compartment, and heated by steam circulating through pipes within the heaters, the water being stationary.

Heating by electricity is as yet but little employed, the only regular installations being those of the local railways in Belgium, and some isolated examples in Switzerland. In Belgium the compartments are heated by rheostats, but the energy expended is seven ampere-hours at 550 volts, per train of two carriages.

The Constitution of Cast Iron.

At one time it was supposed that the nature of cast iron could be determined by making a chemical analysis, but it was soon found that physical constitution and chemical analysis bore relations which were by no means easily understood. With the improved method of studying the physical constitution of metals, however, it has become possible to re-open the case, so to speak; and in the paper recently presented before the American Institute of Mining Engineers, by Professor H. M. Howe, the current opinions in regard to the constitution of cast iron are examined and discussed at some length.

Dr. Howe remarks that it is probable that the slow progress in learning the relation between the chemical composition and the physical properties of cast iron has been due to the fact that the problem has not been properly attacked. The hypothesis which he selects is that which assumes that composition governs properties in cast iron in the same general way as in the case of steel, and he then proceeds to extend the existing knowledge in the case of steel to cast iron.

Carbon steel, when cooled slowly, consists of ferrite, or pure iron, and cementite, or carbide of iron Fe_3C, the former being very soft, the latter very hard. In the case of steel, the inter-stratification of these two components produce the various results observed; in the case of cast iron, carbon in the form of graphite enters into the composition.

White cast iron is really similar in composition to steel, except that the carbon content has reached a higher limit, usually taken as somewhere between 2 and 3 per cent. Common, or graphitic cast iron, which consists of white cast iron as a matrix, containing a varying percentage of graphite.

In the case of white cast iron it is found that whereas the ductility diminishes and the hardness increases continuously as the carbon increases, the tensile strength increases only until the carbon reaches about 1 per cent., and then in turn decreases.

With graphitic cast iron, when the graphite is constant and the combined carbon varies any increase in combined carbon should cause an increase in hardness and a decrease in ductility, the tenacity increasing until the combined carbon reaches 1 per cent. When the combined carbon remains constant and the graphite varies, the strength, ductility and hardness should all decrease with the increase in graphite.

With ordinary foundry irons the total carbon varies but little so that as the combined carbon increases the graphite decreases. Examining the various combinations of ferrite, cementite, and graphite according to the methods of metallography, Professor Howe shows the important influence of the nature of the carbon present upon the physical constitution and the properties under test. This is readily seen from the respective properties of the constituents. Ferrite is soft, ductile, and copper-like; cementite is brittle, and almost glass-hard, while graphite is soft and granular.

In examining the question of the constitution of the strongest cast iron Professor Howe shows that there is an increase in tenacity for a carbon content up to 0.80 per cent., and a decrease as the carbon rises beyond 1 per cent. This would lead to the idea that an important line of progress would be the production of cast-iron castings lower in carbon than our present ones. This, however, must depend, as has already been shown, upon the distribution of the carbon between the states of graphite and cementite, and by conditions of melting, etc.

In this connection some interesting facts are given as to the relative strength of cast iron melted in a reverberatory furnace and in a cupola, these showing the air furnace castings to be decidedly the stronger. Since the cupola is a carburizing furnace and the air furnace a decarburizing one

this bears out Professor Howe's hypothesis. In regard to the influence of ferro-silicon upon the product of the cupola Professor Howe has somewhat to say:

"The notion that the addition of ferro-silicon increases the quantity of scrap which a cupola charge can carry has been ridiculed. It is however eminently reasonable. When scrap iron is melted in the cupola furnace it tends to lose silicon without correspondingly losing carbon, for the simple reason that, while the silicon which is burned away as the iron drops past the tuyeres cannot be readily restored in the cupola, the carbon simultaneously burned away is so restored.

"Now the removal of the silicon tends to diminish the graphite in the resultant casting, and thereby to increase the quantity of combined carbon; thereby to increase the cementite; and thereby to make the resultant castings harder and more brittle. The addition of ferro-silicon raises the silicon in the castings; thereby increases the graphite; and thereby diminishes the combined carbon. Or, it is probably more accurate to say that the addition of ferro-silicon diminishes the amount of combined carbon by lowering the solvent power of the solidifying iron for carbon, thus forcing part of the carbon out of combination into the form of graphite, and this reduction of the amount of cementite, or of combined carbon, softens the castings. One would naturally suppose that even a charge of scrap cast iron alone could readily be converted in good gray castings by the addition of a sufficient amount of ferro-silicon. Such a charge of scrap, when melted, would in any event have sufficient carbon to make it brittle and intensely hard, provided no silicon at all were present. The addition of ferro-silicon should diminish the combined carbon in such castings, and this itself would make the castings softer."

"Mr. W. J. Keep finds the most conclusive proof that the existence of combined carbon has no influence, unless to weaken a casting by making it brittle,' and as regards graphite, that 'strength or weakness seem to be absolutely independent of this element.' These inferences he draws from a great number of cast irons varying but little in total carbon. In such a series, as the combined carbon increases, the graphite must decrease; so if both the combined carbon (in excess of 1 per cent.) and the graphite weaken and embrittle the cast iron, the effect of the increase of one in such a series as his might be masked by the effect of the simultaneous decrease of the other. Thus one might very readily be led to Mr. Keep's conclusions, and fail to note that they are probably true only for approximately constant total-carbon. While it may be true that, for any given percentage of total-carbon, as in his data, variations in the condition of that carbon have relatively little influence (the state of cementite injuring the strength about as much as that of graphite), this is no evidence that each of these substances by itself is harmless. It would be about as logical to infer that neither graphite nor combined carbon weighed anything, because changing carbon from one state to the other did not affect the weight of the cast iron as a whole, as to infer that neither separately effected the strength or ductility, from the fact that shifting the carbon from one state to the other does not greatly affect those properties. The resultant of two equal and opposite forces, no matter how powerful, is zero."

Waste in Water Supply.

THE recent convention of the American Water Works Association in New York was the occasion for the presentation of several papers bearing upon the question of waste water supply in cities, the most important of these being contributed by Mr. Clemens Herschel, the well-known hydraulic engineer, others being by Mr. H. C. Hodgkins and S. J. Rosamond.

Mr. Herschel starts out to prove what at first appears to be an altogether self-evident proposition, that "thrift in the operation of water works is more economical than waste!" He takes this position because of the very general practice of proceeding on the contrary basis, and assuming that the proper thing in nearly all cities is to permit all the waste possible, and then extend the water works to supply the deficiencies caused by waste. This absurd position becomes more evident than ever when water purification schemes are considered and when millions are designated for the construction of water-purification plant when 75 per cent. of this expensively

treated fluid is afterwards to be permitted to run away unused.

"It often becomes, and will continue to be desirable to purify water before it is delivered, but the enormous quantities wasted render such purification works very difficult to encompass. The cost becomes extremely burdensome when added to the already great cost of delivering these extravagant quantities of water under fire pressure, at the tap of the consumer. The large quantities drawn, mostly waste, cause the street mains and other conduits to become too small for the service demanded of them; this causes a lack of fire pressure, and great sums of money are constantly demanded for the purpose of furnishing larger mains and other conduits. The water originally delivered, now becomes sewage, is cast in huge volumes into the nearest water course —an entirely unlawful proceeding, be it noted, unless the receptacle be a tidal stream. It were well to purify this sewage, and communities can always be compelled by law to purify it, but its enormous volume, mostly waste, renders such purification nigh impracticable.

"So the sewage is allowed to pollute streams which should be the sources of city water supply, and thus natural bodies of water fit to be the sources of such water supply for the same, or for other cities, are made difficult to find, and these water-supply works are made many fold more expensive than need be—all this, it will be observed, to the end that needless waste may continue."

Mr. Herschel then proceeds to show how waste may be averted, or at least greatly diminished, by a judicious system of metering. Meters on the house service pipes should certainly be employed in all cases, and in the papers of both Mr. Rosamond and Mr. Hodgkins will be found interesting information as to the detection of local leaks by the use of meters. Householders should be taught to welcome meters as means of reducing their own payments for the wastefulness of others, as in nearly every instance the heavy wastes occur in manufacturing establishments, the cost being divided up among the community when meters are not used. District meters also render much service in detecting leaks in mains, since the readings during the night hours, when there are no demands upon the house services, will give clues as to wastes of this kind. The only reasonable way of diminishing waste is to apply the same commonsense method as is used in other kinds of work; to measure what goes in and what comes out, and charge people for what they receive, whether they use it or not. Such a rule, properly carried out, would soon cause waste water to disappear, and so far from injuring public health, since it would enable it to be greatly improved, it would permit the introduction of both water and sewage purification plants at reasonable cost, where now the expense is prohibitory.

There is, of course, one side of the case to which the work of the engineer does not apply, namely the fact that it is to the interest of those politicians who benefit by increased public expenditures, to permit those expenditures to be as large as possible. Since water-works engineering is almost invariably mixed up with politics it is evident that waste will not be restricted unless the politicians' side of the question can be settled satisfactorily. Since political engineering is beyond the scope of this publication, this branch of the subject cannot be dealt with here, but its existence must be well known to all hydraulic engineers who have approached the water-waste problem.

The Transactions of Technical Societies.

ASSOCIATIONS and institutions of professional men fulfil many valuable functions, and their progress and prosperity is greatly to be desired for many reasons. Naturally the prinicipal object of such bodies is to promote the friendly relations of the members to each other and permit the interchange of opinions and experience which could otherwise hardly take place. With these advantages also come the benefits gained by the contributions of papers upon professional topics, and these papers usually extend the information and experience of the members to interested readers at large, either through the medium of published transactions or through reprints in the technical journals.

The recent convention of the American Railway Master Mechanics' Association at Saratoga was the occasion of the appearance of a number of papers which came

so disappointingly near being of much value that some discussion of the manner in which such papers are prepared may be permitted, together with friendly criticism of their shortcomings.

Thus, for example an apparently very complete paper upon the important question of the "Cost of Running Trains at High Speed" is received, and coming from a body of men so close to the actual facts as the Master Mechanics, one can hardly be blamed for expecting to find much valuable information upon this mooted topic.

Upon examination, however, the paper shows that it has been produced in the following manner. The question having been proposed, it was referred to a committee of three members especially competent to discuss it most intelligently. This committee sends out letters to the officials of important roads operating high-speed trains, together with a schedule of questions, answers to which would undoubtedly furnish valuable material for the work of the committee. So far, this is most excellent. When the information is received, however, instead of being digested and edited so as to eliminate all irrelevant matter and collect the reliable data in comparative form, it is simply printed in a string, without arrangement or analysis, and apparently without especial weight as to comparative value. As a consequence, the seeker for information is obliged to do for himself what the committee in charge of the matter should have done for him, and lacking their experience and familiarity with the subject, much of his effort is wasted. The work was so well started, that one cannot but regret that it was not properly completed. Similar conditions appear in other papers presented before the convention, and this leads to the question as to the best method of preparing professional papers for technical meetings in general.

The original idea of a professional paper was that it should be distinctly personal and representative of the professional work and knowledge of the writer. This is most desirable when it can be secured, although in practice the "but" is a large one. The ablest professional men are often too busy, and it is difficult to induce them to contribute to society transactions matter which forms an integral part of their regular business. Again many men of eminence in successful practice have not that facility in writing which lends itself to a ready account of matters about which they know so much, and if that facility is not always found among professional engineers, it can hardly be expected among master mechanics and superintendents, although these are often the men whose experience would be most eagerly welcomed by the profession.

Papers prepared in collaboration have often been most successful. Indeed it is not uncommon to find papers presented by professors and instructors with the distinct acknowledgment of the valuable assistance which has been rendered in investigation and computation by students and subordinates, under the direction of the superior. This leads directly to the committee method, as undertaken by the Railway Master Mechanics, with the important difference that the paper is avowedly prepared by a responsible head, by whom the matter is digested and edited in shape for discussion and practical use.

It is the general experience in technical societies that the best papers are usually those which elicit the most discussion, and discussion can hardly be had intelligently upon a paper which is not in form for ready assimilation and use. It was at one time suggested in one of the national societies that the author of each paper be requested to furnish with it a systematized abstract for use in presenting the subject before the meeting, when the point at once arose, that in that case there would be no necessity for the paper itself, the abstract becoming in fact the paper.

By all means let the custom of sending out correspondence upon technical subjects for society papers be continued, but let it be understood that the chairman of each committee having such work in hand act as editor of the matter received, placing it in formal and systematized shape for discussion and criticism, so that the valuable matter thus collected may be made immediately available.

An excellent lesson in this line may be obtained from the manner in which the papers, or reports, are prepared in connection with the international engineering congresses held in connection with expositions.

Committees are appointed, generally from the numbers of experts in the respective subjects, and these committees send out data and receive information and correspondence, this material being then discussed in committee and incorporated into reports which practically comprise the latest word upon the various subjects.

The principal function of such committees is editorial, and the result is that the reports form the most valuable additions to current technical and professional literature which can be obtained. The technical societies have done much good work in the past, even with the crude methods employed in some instances, and with but little modification these methods may readily be converted into the most efficient system possible for providing valuable contributions to technical knowledge.

The Status of the Civil Engineer.

AT the recent convention of the American Society of Civil Engineers the perennial question as to the possibility of doing something to limit the practice of civil engineering to such as may be in some manner officially qualified, came up once more.

It was again formally announced, in a communication from a highly esteemed member, that anyone may practice civil engineering without special permission, if he can be so ingenious as to find anyone upon whom he can practice. This deplorable state of affairs was compared with the far more desirable arrangement existing in the professions of medicine, law, and divinity, (everyone knows that there are no shyster lawyers, quack doctors, or fake clergymen), and hence the importance of remedying this great evil. Legislation was called for in order to enable the engineer to have his calling restricted to competent men "out of a spirit of loyalty to the profession!"

This would all be most amusing if it were not propounded in such a spirit of serious solemnity. A body of men, most of whom have risen to eminence in the great profession of civil engineering because of the very freedom with which they were allowed to enter it, and mount to its highest honors by their own efforts, is urged to call for legislation "out of loyalty to that profession," and bar the entrance through which most of its members came. Hardly less amusing are the suggestions which were made as to the manner in which the bars should be put up. First of all the exact meaning of the term civil engineer should be defined. From this it would appear that the members of the esteemed society referred to have as yet been in ignorance of what they really were, a most deplorable condition of affairs. Second, a state board of examiners should be appointed; thus making entrance into the profession possible by systematic cramming for "exams," such as prevails in practically all methods of grading by examination. Third, licenses to be handed out; these to be in three grades, according to the degree of "eminence" of the handee. How the degree of eminence is to be determined is not stated. Fourth, heavy punishment to be provided for anyone attempting to practice without a license, no matter how well his work may be done. Fifth, and most convenient, a provision to be made to let in without examination all those who have been in practice for 15 years, as well as such others as may show evidence of their attainments. This provision is the most ludicrous of all, since these are the very men who, if their pretensions were at all well founded, should not have the slightest difficulty in passing an examination. Seventh, the revoking of licenses for unprofessional conduct. What constitutes unprofessional conduct, and by whom decided, not stated.

Discussion on this latest development of a time-worn topic is indeed unnecessary, and the Society certainly did the right thing in referring it to a committee, by whom it is to be hoped it will not be treated more seriously than it deserves.

The Principles of Cost Accounting.

THERE is probably no one feature in the modern development of skilled works-management which has attracted so much attention of late as that department which relates to the correct determination and apportionment of factory costs. The popularity of recent articles in the pages of this magazine bears witness to the desire of works managers to familiarize themselves with the practice of various establishments, while the extent to which the subject has been treated elsewhere indicates the prevailing interest.

An excellent contribution to this branch of technical literature is found in the address delivered by Mr. F. A. Halsey before the mechanical engineering students of Cornell University, and published in recent issues of the *American Machinist.*

Mr. Halsey first calls attention to the difference between cost keeping and ordinary bookkeeping. The latter is always very precise even if not always accurate, and it is often more concerned with the form than with the substance of the transactions which it records. There is a fictitious appearance of exactitude based upon elements which must always contain a large element of guesswork. The engineer, on the contrary, is accustomed to work within certain limits of error, and is more concerned with facts than with the precision of the form in which they are recorded.

The cost of a machine to its producer is composed of three items—material, labor and burden. The term material explains itself, but labor is here used in a restricted sense, and means the wages of those operatives whose time is so spent that it can be accounted for and charged to the separate articles made. Such labor is properly defined as direct labor, though more commonly called productive labor. By burden is meant a factor which is added to the cost of material and direct labor to cover such items of the cost of production or of the conduct of the business as cannot be directly charged to the individual pieces produced. The burden is made up of many items, such as the cost of rent (if the business is conducted in rented quarters), of salaries, power, heat and light, insurance, taxes, and what is properly called indirect labor, though more commonly, but erroneously, called non-productive labor—by which is meant the labor of men who appear on the weekly pay rolls, but whose labor is of such a nature that it cannot be directly charged to any individual article produced for sale. Among such men are the foremen, the engineer or fireman, and many of the helpers or laborers about the shop, crane operators, etc.

As Mr. Halsey says, the problem of cost accounting resolves itself principally into burden accounting, and as it is found that the burden is rarely less than 100 per cent. of the wages, this is as important an element as the direct wages account. The total burden is not difficult of determination; fuel, interest, rent, insurance, depreciation, can all be made matters of record. Indirect labor may be recorded by keeping a daily running account to which all labor is charged for which no order number can be found, and the total taken and added to the burden whenever an inventory is made.

Two methods have been devised for the distribution of the burden; the percentage plan and the hourly-burden plan.

"Under the percentage plan the gross burden for a given period is divided by the gross direct wages for the same period. The resulting ratio, treated as a percentage, gives a factor which, when multiplied by the direct wages on any piece of work will give the burden belonging to the work, and this added to the direct wages will give the final labor cost.

"The great special shortcoming of this plan is that it ignores the element of time, which is a necessary factor. It is obvious that the burden properly chargeable against a given tool would be twice as much for two hours as for one, and yet were a job done to-day by a two-dollar man and to-morrow by a dollar-a-day boy, the boy using the same tool, but consuming twice the time of the man, the wages would be the same, and hence the burden also. This is clearly wrong, since the boy having used the tool twice as long as the man, the burden charged against him should be twice as great. The percentage lan has the advantage of simplicity, as after the wages are calculated for each time ticket, the element of time is lost sight of, all succeeding records and accounts being in dollars only.

"Under the hourly plan the gross burden for a given period is divided by the total number of hours of direct labor for the period, the quotient being a charge per hour which is to be added to each hour's wages on a given piece of work to obtain the labor cost of the work. Taking the previous illustration again, it is clear that the hourly plan would charge the boy with twice as much burden as the man, as it clearly should."

The difficulty with the hourly burden plan lies in the fact that it does not meet the interest and depreciation charge. This is a matter of minor importance with small

tools, upon which these items bear but a small ratio to the labor. With large tools, however, it is different, and under such circumstances it is necessary to make some provision for the interest and depreciation apart from the hourly burden if a fair distribution is to be made.

"When the subject comes to be considered in detail it soon appears that there are other items besides interest and depreciation which should be considered in this connection. The burden may in fact be considered as composed of two burdens—the man burden and the tool burden—since some of the expense is incurred because of the men and some because of the tools. For instance, heating and lighting are needed by the men only, since, as far the tools are concerned, they could do their work just as well in the cold and dark. On the other hand, the power is consumed by the tools. Some items are not easy to classify or divide. For instance, both men and tools need protection from the weather, and the charges on the building are thus properly chargeable in part to both, though just how the division should be made is not easy to decide. Insurance on the tools themselves is of course chargeable to them only, whereas insurance on the buildings is chargeable to both tools and men. The expense of superintendence and foremanship, except as it relates to the installation of new tools or to repairs, is obviously chargeable to the men."

Mr. Halsey is inclined to be rather conservative in the matter of deprecation and although he admits that in such plants as rolling mills and the like, where improvement is rapid and revolutionary, the life of the plant is estimated at ten years, he assumes in general a useful life of twenty years for machine tools. This may be safe, but it is hardly wise to make any rule, and the better plan is to decide each case on its merits, and incline rather to too great rather than too little deprecation.

It is a healthy sign of the times when it is realized that such subjects are being discussed before engineering students, and the work of the machine shop of the immediate future will doubtless be all the better for the familiarity with shop accounting possessed by the men to whom the conduct of such establishments must soon be intrusted.

The Regulation of the Mississippi River.

River improvement works are usually designed with the especial intention of protecting the banks and maintaining a reasonably constant channel, but with this comes also the important question of the protection of the water fronts of cities.

In a recent issue of *Engineering News* is a paper by Mr. L. W. Brown upon the protection of the water fronts of cities in the Mississippi valley, which contains some interesting views, here given in abstract.

The method adopted by the Mississippi River Commission twenty years ago is that known as the spur-dike and mattress system, and although it has been successful in many instances, it does not always produce satisfactory results. Spur dikes sometimes fail in their purpose because it is the practice to place them directly in the apex of a caving bank, in which position they form a true dam, decreasing the sectional area of the stream and checking the flow until a sufficient head is produced to increase the velocity and permit the given volume to flow through the contracted channel. This produces cross currents which set against the banks, producing erosion and caving. Mattresses are only efficient when the work is begun at the point where the abrading commences, and continued smoothly along the entire surface to be protected.

The pile bank protection, advocated by Mr. Brown, practically consists in the construction of a system of braced piling, with tops above maximum flood heights, and extending out into the stream to such a line as will best receive and guide the current past the abrading stretch, providing a depth of 30 feet or more of flood river to impinge against the piles. The outer, or bulkhead row of piles form a water-tight sheet piling, and the whole forms a support for the levee. This construction stops the abrasion and causes accretion to commence, while an earth filling can gradually be put in and a new slope bank constructed before the front bulkhead has deteriorated to such an extent as to require renewal.

"The advantages claimed for this system of pile protection are, that it extends continuously from the upper end of an abrading bank far enough into the bend to throw the current away from the shore. It extends sufficiently high into the highest

flood line and far enough out into the river to affect 30 or 40 feet in depth of river at high water. The piles are placed at uniform distances apart and provide a uniform resistance to the current striking them. The front or river line of the work is placed on a line best adapted to receive and guide the current past the bank where abrasion was previously taking place.

"The whole theory of the success of work of this type is that a safe and uniform velocity is given to the river current; eddies, cross currents, etc., are obliterated, and the uniform resistance of the piles to the flow checks the current sufficiently to allow suspended matter to be deposited on the bank previously abraded. Finally, the extent of the possible movement of the river bed towards the opposite shore is only limited by the gradual extension of the pile protection work into the river."

Coaling by Machinery.

THE coaling of vessels is always a tedious undertaking, and from its nature is generally performed by hand. Time will rarely permit the taking of a vessel to the coal docks to receive the coal through chutes leading directly from the coal bins, and in any case the coal cannot be received faster than it can be stowed and trimmed in the ship's bunkers. The general practice therefore, is for each vessel to receive coal from barges brought alongside while the ship is lying by its dock.

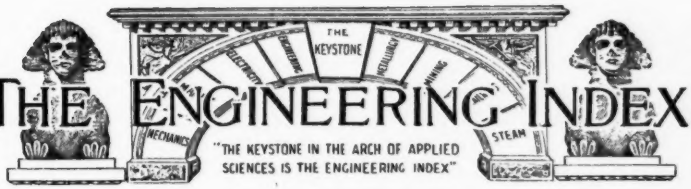
There has recently been placed in operation in New York an improved form of coaling barge which appears greatly to facilitate the tedious work of coaling from barges, and from an account in the *Iron Age* the following description is abstracted.

The usual method of transferring the coal from the barge to the steamer is to shovel the coal by hand into baskets, bags, or iron buckets on the barge, these being lifted by a whip hoist, operated from the steamer, and lowered and dumped into the bunker opening. Here it slides down a chute into the bunker, where it is stowed in place by the trimmers, this work being most exhausting in the unventilated bunkers.

"By the new method the coal is contained in a steel barge of 1,000 gross tons capacity, divided by transverse bulkheads into several compartments or coal bins. The floor of each bin is raised above the bottom of the barge, to accommodate a passageway which runs the whole length of the bins, just above the keel, and in which a train of buckets is drawn by an endless chain composed of flat steel links. There are three square openings in the bottom of each bin, closed by sliding doors, and as each hole is opened the coal lying above it slides down into the buckets. The train of buckets is moved by means of a steam engine in the rear compartment of the barge, through the horizontal passageway, then vertically upward in a tower which contains two automatic weighing and recording scales, into one of which each alternate bucket is dumped. The coal then slides from the scales into two telescopic steel tubes, which deliver it into the bunkers of the steamer. The principle of the coaling barge is therefore similar to that of the well-known floating grain elevator, but the machinery is much heavier and contains many devices to facilitate the handling of a somewhat intractable material like coal.

"The barge delivers the coal steadily at the rate of 125 gross tons per hour, and has been operated for several hours at a time at a rate of 135 tons. The whole operation is almost noiseless and free from dust, and it is accomplished entirely by the machinery of the barge, without any hand labor and without the assistance of any of the machinery or crew of the steamer."

There is no doubt that this apparatus greatly facilitates the handling of the coal, so far as its delivery to the bunkers is concerned, and to this extent it is an undoubted improvement. What is now needed is some improved form of stowing which will relieve the trimmers. This will doubtless involve an entire re-arrangement of the bunker system, and many objections to any such would doubtless be made by ship-owners and masters. Such exhausting and brutalizing labor, however, demands every possible effort to secure its amelioration, and improvement must ultimately come. When to this is added a satisfactory form of mechanical stoker for marine service, the most objectionable features of steam navigation will have disappeared, and both problems are before the mechanical engineers of Europe and America for solution.



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Bascule.

A Long Span Bascule Bridge Over the Chicago River. An illustrated account of interesting bridge construction, with statement of conditions. 1000 w. R R Gaz—June 7, 1901. No. 41538.

Concrete.

The Northampton Concrete Bridge, Central Railroad of New Jersey. Illustrated description of a three-track railway arch with spans of 52 and 34 ft. The bridge was built without interfering with traffic over the truss spans which it replaced. 2000 w. Eng Rec—June 8, 1901. No. 41462.

Floor.

Floor System of the New East River Bridge, New York. Cross-sectional views, giving an idea of the carrying power of this new bridge, with description of the stiffening trusses, constructed on the riveted system, and the horizontal system of trussing to resist wind-pressure. 1600 w. Sci Am—June 15, 1901. No. 41588.

Girders.

An Enclosed Plate-Girder Park Bridge. Illustrated description of a steel bridge covered with concrete to give the appearance of masonry, built on the Vanderbilt estate of Biltmore from the plans of Richard M. Hunt. 800 w. Eng Rec—June 1, 1901. No. 41341.

I-Beam Girders with Re-enforcing Plates. C. F. Blake. Chart and tables convenient in the calculation of the strength of I-beams re-enforced with cover plates upon the flanges, with explanation. 400 w. Am Mach—May 30, 1901. No. 41295.

Inspection.

Bridge Inspection. George H. Burgess. Considers the methods of inspection of steel bridges only, describing the ordinary practice. 2500 w. Wis Engr—May, 1901. No. 41385 D.

Iron Bridges.

The Development of Iron Bridge Construction. Charles S. Davis. A brief review of this work and outline of the methods of conducting the business of a bridge plant, and the need of rapid methods of calculation. Ill. 2200 w. Trans Assn C. E. Cornell Univ. 1901. No. 41387 D.

New York.

Substructure for the Fourth East River Bridge, New York City. Abstract of the specifications for material and workmanship are given, with illustrations of details. 2600 w. Eng News—June 20, 1901. No. 41816.

Niagara.

The Horizontal Thrust of the Niagara Falls and Clifton Arch. R. A. Pendergrass. Mathematical determination. 1000 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41390 D.

The International Bridge, Buffalo. Illustrated description of the method of removing the spans of a bridge across the Niagara River and replacing them with heavier spans without any material interruption of passenger traffic. 2500 w. Eng Rec—June 15, 1901. No. 41557.

Railroad Bridges.

New York Central Bridges. Charles N. Green. An illustrated article giving information of designs and methods used in the extensive reconstruction work of the road named. 2500 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41394 D.

Spain.

The Cabe Bridge (Puente del Cabe). José María Sáinz. Description in detail of a new bridge, 40-metre span, to carry the highway from Monforte to Lalín across the Cabe river at Chantada, northwest Spain. 2500 w. 2 plates. Revista de Obras Publicas—June 13, 1901. No. 41780 D.

Standards.

Short-Span Railway Bridge Standards. Explains the method of the Santa Fe Railway for systematizing its bridge work. 700 w. Eng Rec—June 15, 1901. No. 41559.

Test.

Test of the Bridge at Heusden (Beproeving van de Brug bij Heusden). H. van Oordt. Report of official test, with description of instruments for measuring deflection, and tabulated results. 10000 w. Tidschr v h Klik Inst van Ing—Feb. 9, 1901. No. 41765 H.

Transfer Bridge.

Standard Transfer Bridge for Car Floats—New York Central & Hudson River Railroad. Illustrated detailed description of the method of transferring cars from the float to the shore, including the construction of the bridge, apron and operating machinery. 1700 w. R R Gaz—May 31, 1901. No. 41312.

Viaduct.

Double-Track Railway Viaduct Over the Des Moines River. Illustrated description of a viaduct nearing completion, remarkable for the combination of height and length. 600 w. Sci Am—June 1, 1901. No. 41285.

Riverside Viaduct. John W. Ripley.

Illustrated detailed description of this fine viaduct in New York. 2600 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41396 D.

CANALS, RIVERS AND HARBORS.

Bar Removal.

Dynamiting Sand Bars. Reviews a report on an attempt to blast a channel through a sand bar at Brunswick, Ga., the work costing twelve times as much as dredging. 1600 w. Eng Rec—June 8, 1901. No. 41461.

Breakwater.

The Buffalo Breakwater. Thomas Symons. An outline of the development of Buffalo harbor, briefly describing some of the works now being built to provide for the accommodation of commerce. 7600 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41388 D.

Chicago.

Chicago Harbor. Robert B. Wilcox. A statement of the conditions, discussing the past and future improvements. 4000 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41393 D.

Dams.

Coefficient of Friction in Dam Design, and the Failure of the Dam at Austin, Tex. H. P. Gillette. Discusses the theories advanced to explain the failure of this dam. 2800 w. Eng News—May 30, 1901. No. 41305.

Some Dams Recently Constructed by the Spring Brook Water Supply Company. John H. Lance. Description of the larger of these dams and the methods employed. 5700 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41395 D.

Some Dams Recently Built by the Spring Brook Water Supply Company. Describes masonry dams 73 and 104 ft. high, of unusually heavy cross-section, and explains the method of carrying pipes through a 37-ft. earth dam on heavy masonry foundations. 2800 w. Eng Rec—June 15, 1901. No. 41558.

Dikes.

The Dikes of Holland. Gerard H. Matthes. Reviews the history of the building of the dikes, the reclaiming of the land, formation of lakes, and the engineering problems connected with the work. Ill. 7000 w. Nat Gaz Mag—June, 1901. No. 41375 C.

Dock Gates.

Gate Machinery for Mersey Docks. An illustrated description of hydraulic machinery. 3500 w. Engr, Lond—June 4, 1901. No. 41840 A.

Drainage.

The Drainage of Marajo Island (De Afwateringskwestie van het Eiland Marajo). H. L. van Hooff. An examination of the topography of Marajo island, at the mouth of the Amazon, showing the engineering work necessary for its reclamation by drainage. 15000 w. Tidschr v h Klik Inst van Ing—Feb. 9, 1901. No. 41764 H.

Dredges.

Hydraulic Hopper Dredges for Harbor Improvement at New York. Illustrated description. 1400 w. Marine Engng—June, 1901. No. 41529 C.

Dry Dock.

See Electrical Engineering, Power Applications.

Filling.

Filling in Tide-Water Flats at Seattle, Wash. Brief account of the work in progress. 1000 w. Eng News—June 13, 1901. No. 41586.

Flow.

A New Formula for Determining the Flow of Water (Studie über eine Neue Formel zur Ermittlung der Geschwindigkeit des Wassers). R. Siedek. An examination of the formulas of Bazin and of Kutter, and the derivation of a new formula, especially applicable to rivers and streams. Serial, Part I. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—May 31, 1901. No. 41719 B.

Isthmian Canal.

An Isthmian Canal From a Military Point of View. Peter C. Hains. Full paper presented before the Am. Acad. of Pol. & Soc. Sci. Showing that a neutral canal is a more useful canal to the United States than one controlled by military power. 4000 w. Jour U. S. Art—May-June, 1901. No. 41601 D.

Java.

A General Plan for the Irrigation of Java (Een Algemeen Irrigatie-Plan voor Java). H. H. van Kol. A comparison of the conditions of Java with those of British India, and a recommendation of the adoption of a consistent irrigation system for the whole island. 3500 w. De Ingenieur—May 25, 1901. No. 41770 B.

Mississippi.

The Protection of Cities in the Mississippi Valley Against the Encroachment of the River. L. W. Brown. An illustrated study of the conditions and the systems of protection thus far tried. 3700 w. Eng News—June 13, 1901. No. 41579.

Prussian Canals.

The Prussian Canal Projects. Editorial discussion of the new schemes, their main features, and some particulars. 3600 w. Engng—May 24, 1901. No. 41366 A.

Rhone.

The Motive Power of the Upper Rhone (Les Forces Motrices du Haut-Rhône). A. Garcia. A study of the best method of utilising the hydraulic power of the Rhône in France between the Swiss

frontier and Pyrmont. More than 160,000 h. p. is available. 10000 w. Mem Soc Ing Civ de France—April, 1901. No. 41728 G.

Scheldt.

The Improvement of the Scheldt in Belgium (Dei Verbetering van de Belgische Schelde). J. W. Welcker. An account of the plans for the improvement of the Scheldt between Antwerp and Fort Lillo, including the proposed cut-off. 8000 w. De Ingenieur—April 6, 1901. No. 41766 B.

Zuider Zee.

Reclaiming the Zuider Zee. A brief account of how this great work is to be carried out, with an estimate of the cost. 1100 w. Engr, Lond—May 31, 1901. No. 41497 A.

The Drainage and Reclamation of the Zuyder Zee (Afsluiting en Droogmaking van de Zuiderzee). A review of the financial and commercial conditions involved in the conversion of the Zuyder Zee into available land. 2000 w. De Ingenieur—May 25, 1901. No. 41771 B.

CONSTRUCTION.

Building Details.

Light and Air in Tenement Houses. Describes the conditions in New York tenement houses under existing laws, and gives notes of the conditions in 1878, when the subject first received widespread attention. 3500 w. Eng Rec—June 15, 1901. No. 41564.

Dome.

The Iron Construction of the Dome of the New Government Building at Bern (Die Eisen Neuen Bundeshause in Bern). F. Schüle. An interesting example of structural building construction, with plans and details and a view of the completed work. 1800 w. Schweizerische Bauzeitung—June 1, 1901. No. 41758 B.

Fireproof Construction.

Fire-Proof Building Construction. J. T. Richards. Discusses the materials used, the systems of construction, etc. Ill. 1800 w. Wis Engr—May, 1901. No. 41384 D.

Foundations.

Air versus Water. John F. O'Rourke. Discusses difficult work in building foundations, the methods used, etc. Ill. 4700 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41392 D.

Interior Lighting.

A New Era in Interior Lighting. Charles L. Norton. An account of the progress made in the use of diffusing glass, the changes due to its adoption, and some of the varieties. Ill. 4000 w. Tech Quar—March, 1901. No. 40976 E.

Lighthouse.

The Greens Ledge Lighthouse. Illustrated description of a new lighthouse being erected in Norwalk (Conn.) harbor, and the methods of construction. 1600 w. Ir Age—June 27, 1901. No. 41860.

Shield.

The Use of the Shield in the Construction of Tunnels (L'Emploi du Couchier à la Construction des Tunnels). An exhaustive critical study of tunneling by means of the shield, with accounts of numerous applications. Serial, Part I. 2500 w. Revue Technique—May 10, 1901. No. 41710 D.

Tunnels.

The Stralau-Treptow Tunnel Under the River Spree. Brief illustrated account of the first submarine tunnel ever constructed in Germany. 700 w. Sci Am—June 22, 1901. No. 41696.

Tunnel Lining Without Traffic Interruption. Willard Beahan. An illustrated account of work on the Musconetcong tunnel on the Lehigh Valley R. R. in the State of New Jersey. 3700 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41391 D.

See also Civil Engineering. Measurement.

Underpinning.

Supporting a Brick Wall From One Side Only. Illustrated description of the manner of underpinning a Boston building by raking struts, suspender rods and cantilever beams, so that the interior of the building was not affected. 900 w. Eng Rec—June 1, 1901. No. 41345.

MATERIALS.

Cement.

Cement in Canada, Latin America, and the West Indies. Information concerning the cement trade. 6000 w. U. S. Cons Repts. No. 1052—June 3, 1901. No. 41329 D.

Notes on Cement. J. R. Gardiner. A synopsis of what has been written on this subject, given in a concise form. 2000 w. Can Archt—May, 1901. No. 41326 C.

Notes on Cements and Cement Testing. Henry Fox. Gives a description of the raw materials in the composition, and a method of converting the same by means of a chemical and mechanical process into a fine powder of double silicate or calcium and alumina, and discusses methods of testing. Ill. 6700 w. Wis Engr—May, 1901. No. 41383 D.

The Manufacture and Testing of Portland Cement. Walter E. Bush. This paper gained a special prize offered by the Cement Users' Testing Assn. Reviews the history of the inception and progress of this material, the manufacture, the kilns and grinding machinery, and methods of testing. 5000 w. Quarry—June 1, 1901. No. 41594 A.

The Setting of Portland Cement. Gavin J. Burns. Diagram showing the mi-

croscopic appearance while setting, with description of the process whereby the cement is converted into a solid mass. 1200 w. Builder—June 15, 1901. No. 41827 A.

Cement Mortar.

The Use of Trass and Puzzolana With Portland Cement Mortar (De Toevoeging van Tras en andere Puzzolanen aan Portlandcement Mortel). H. Wortman. With record diagrams of tests, showing the economy and advantage of a judicious admixture of puzzolana. 3000 w. De Ingenieur—May 18, 1901. No. 41769 B.

Concrete.

Concrete Construction. C. R. Neher. Practical suggestions from the standpoint of the purchaser and contractor, as well as the engineer. Ill. 3000 w. Jour Assn of Engng Socs—April, 1901. No. 41292 C.

Concrete-Steel.

An Accident to a Concrete-Steel Grain Bin. Illustrated description of a bin which burst when filled with grain; the walls were of concrete reinforced by rings of strap-iron. 600 w. Eng Rec—June 1, 1901. No. 41342.

Granites.

The American Granites. A summary showing where the main deposits now being worked are formed, and information concerning the varieties and quality. 1600 w. Stone—May, 1901. No. 41698 C.

Serpentines.

The Serpentines of Manhattan Island and Vicinity and Their Accompanying Minerals. D. H. Newland. Concerning their distribution, general features, chemical composition, etc. 3600 w. Sch of Mines Qr—April, 1901. Serial. 1st part. No. 41671 D.

Timber.

Composite Timber Columns. Halbert Powers Gillette. Gives deductions which seem to indicate that under certain conditions composite columns may be considered as acting like a single solid stick. 1000 w. Eng News—June 13, 1901. No. 41585.

MEASUREMENT.

Alignement.

The Alignement of the Simplon Tunnel (Ueber die Absteckung des Simplon-Tunnels). Max Rosenmund. An illustrated account of the triangulation over the Simplon pass in connection with the alignement of the tunnel. Two articles, 2500 w. Schweizerische Bauzeitung—May 25, June 8, 1901. No. 41757 each B.

Surveying.

The Errors of Traverse Surveys. William D. Pence. Reviews briefly the limits of error recommended by various engineers and authors of standard text books, and presents a simple rational method of fixing the permissible error of closure of a traverse survey under known conditions of field work. 3000 w. Pro of Purdue Soc of Civ Engng—1900-1901. No. 41673 D.

The Schroder Tacheograph. Illustrated description of an instrument shown at the Paris Exhibition. A combination of the plane table with the triangle of Prætorius. 3000 w. Engng—June 7, 1901. No. 41608 A.

See also Mining and Metallurgy, Mining.

Triangulation.

The Accurate Measurement of Angles With the Engineer's Transit. F. D. Cunningham. Describes the methods used. 700 w. Eng News—May 30, 1901. No. 41308.

MUNICIPAL.

Garbage.

Garbage Cremation at Evanston, Ill. Illustrated description of a furnace used to destroy garbage only. 600 w. Eng Rec—June 8, 1901. No. 41469.

Garbage Disposal in Lafayette, Ind. Severance Burrage. Illustrated description of the crematory building and methods of collection, with a copy of the ordinance under which the collection is carried out. 2600 w. Munic Engng—June, 1901. No. 41398 C.

Havana.

The Proposed Sewerage and Drainage Systems of Havana. Reviews the report submitted by Samuel M. Gray, in June, 1900, and the specifications for the work, on the outlines finally adopted. Ill. 2400 w. Eng Rec—June 22, 1900. No. 41873.

Pavements.

A Proposed Asphalt-Macadam Pavement. S. Whinery. Proposal to mix the asphalt with broken stone, and then spreading and rolling as in laying ordinary asphalt pavements. 1600 w. Eng News—June 6, 1901. No. 41457.

Is the Continuous Repair System the Most Economical for Macadam Roads? Halbert Powers Gillette. A record of macadam resurfacing, with recommendations of treatment that will prove more economical than the usual practice. 1000 w. Eng News—June 6, 1901. No. 41455.

Some New Ideas in Road Construction. Editorial review of papers by Messrs. Gillette and Whinery. 2000 w. Eng News—June 6, 1901. No. 41458.

Tar Macadam as Used in Hamilton, Ontario. Fred. J. Warren. Report from a personal examination. Ill. 1800 w. Munic Engng—June, 1901. No. 41397 C.

Sanitation.

House Drainage. W. C. Tyndale. Illustrated discussion of methods. 5000 w. Jour San Inst—April, 1901. No. 41275 F.

Plumbing in the Broad Exchange Building. Illustrated description of the work in

a 20-story office building, where the distribution of the water to different floors requires numerous reducing valves and air chambers. 2000 w. Eng Rec—June 15, 1901. No. 41565.

Sanitary Appliances. W. C. Tyndale. Illustrated discussion of the fittings used in the house mainly. 4300 w. Jour San Inst—April, 1901. No. 41274 F.

Septic Tanks.

Experiments on Septic Tank Action at Cornell University. R. B. Williams, Jr. Illustrates and describes the experimental plant for the study of the effects of the various rest periods. 1200 w. Eng News—June 13, 1901. No. 41582.

Sewers.

A Combined Syphon and Overflow. Illustrated description of a short syphon making separate provision for storm water and sewage and having one of the entrance chambers designed to serve as an overflow outlet. 600 w. Eng Rec—June 8, 1901. No. 41467.

The Sewer System of Lake Bluff, Ill. W. T. Griffith. Illustrated description of a combined system of sanitary and storm water sewerage. 1700 w. Eng News—June 6, 1901. No. 41459.

Valuation.

The Appraisal of Plants for Public Services. Nicholas S. Hill, Jr. A review of the principles on which a property is valued when purchased by private parties or by municipalities. 4000 w. Eng Rec—June 8, 1901. No. 41466.

WATER SUPPLY.

Aqueducts.

The Weston Aqueduct of the Metropolitan Water Works for Boston and Vicinity. Details of the structure are given and information concerning the work. 500 w. Eng News—May 16, 1901. No. 40947.

Artesian Wells.

Artesian Water Supply in Australia. W. Gibbons Cox. Gives statistics and particulars of the progress of artesian boring and supplies in Queensland, and related information. 3500 w. Engr, Lond—June 21, 1901. No. 41926 A.

Chicago.

The Water Supply System of Chicago. F. B. Embree. Brief historical review, with illustrations. 1600 w. Sci Am—June 29, 1901. No. 41862.

Cincinnati Intake.

The Break in the Intake Caisson for the New Water-Works for Cincinnati, Ohio. Drawing, with explanation of the cause of the accident as given by Mr. G. Bouscaren, the chief engineer. 700 w. Eng News—May 30, 1901. No. 41303.

Constantinople.

The Water Supply of Constantinople (Die Wasserversorgung von Konstantinopel). H. Gruner. A description of the modern supply of the city, and its recent improvement. 2000 w. Gesundheits-Ingenieur—April 30, 1901. No. 41761 B.

Consumption.

Some Observations on the Household Consumption of Water. Henry C. Hodgkins. Describes the service and gives readings of water meter taken at varying intervals under a variety of conditions. 1800 w. Am Water Wks Assn—June, 1901. No. 41933 C.

Dams.

See Civil Engineering, Canals, Rivers, and Harbors.

Dam Failures.

Accidents to Reservoir Dams. C. Baillarge. Describes the washouts at the reservoir dam at Middlefield, Mass., and that at Chicoutimi, Que. 1600 w. Can Archt—June, 1901. No. 41968 C.

Electrolysis.

An Electrolysis Survey at Columbus, Ohio. Statement of investigations to determine the electric current carried by water-mains, and the suggestions of F. C. Caldwell for avoiding electrolysis of mains. 1300 w. Eng Rec—June 8, 1901. No. 41465.

Elmira, N. Y.

The Elmira Water-Works. J. M. Diven. Illustrated historical account of the works. 2000 w. Fire & Water—June 15, 1901. No. 41639.

Filtration.

Aerator for Mechanical Filter Plant at Winchester, Ky. Leonard Metcalf. Illustrated description. 500 w. Eng News—June 6, 1901. No. 41453.

Six Years of Slow Sand Water Filtration at Mount Vernon, N. Y. Gives a summary of records kept, and details of operation of this plan, which is modeled closely after the one at Lawrence, Mass., and put in operation less than a year after its model. Also editorial giving comparative figures. 4100 w. Eng News—May 30, 1901. No. 41306.

The Filter Galleries at Painesville, Ohio. Illustrated description of galleries built close to the low-water line of Lake Erie, so that wave action on the sand keeps the latter from clogging. 500 w. Eng Rec—June 1, 1901. No. 41340.

Gibraltar.

The Water Supply of Gibraltar. William P. Mason. An illustrated account of the sources of water supply, the storage system, etc. 1100 w. Eng News—June 27, 1901. No. 41883.

New York.

The Croton Dam and Watershed. Describes the distribution system of Manhattan, giving views of the principal works of interest. 6700 w. Fire & Water—June 15, 1901. No. 41638.

Pumping.

Metropolitan Water Works Pumping Machinery. Will J. Sando. Illustrations, data, cost of operating, etc., of the present equipment. 1700 w. Jour N. E. Water Wks Assn—June, 1901. No. 41380 F.

New Pumping Plant of the Pennichuck Water-Works, Nashua, N. H. Illustrated description of a very heavy 6,000,000-gal. pump driven from a turbine making 400 revolutions per minute. 1600 w. Eng Rec—June 8, 1901. No. 41463.

The New Pumping Plant of the Pennichuck Water-Works, Nashua, N. H. F. W. Dean. States the conditions and the objects to be accomplished, with illustrated description of the plant. 1700 w. Eng News—June 6, 1901. No. 41454.

Purification.

Purification of the Chemung River at Elmira, N. Y. James M. Caird. Describes the system of filtration of the Elmira Water Company. 1500 w. Am Water Wks Assn—June, 1901. No. 41936 C.

The Purification of Water. P. A. Maignen. A review of the whole subject as it appeared a half century ago, and as it appears at present. 4000 w. Am Water Wks Assn—June, 1901. No. 41903 C.

Reservoirs.

Jerome Park Reservoir. Illustrated description of this very important wok. 2000 w. Sci Am—June 1, 1901. No. 41287.

The New Water Works Reservoir at Trenton, N. J. Charles A. Hague. Illustrates and describes a reservoir having a capacity of 110,000,000 gallons, and gives a report of its use since Sept., 1899. 2300 w. Eng News—June 13, 1901. No. 41584.

St. Louis, Mo.

St. Louis Water Works—Distribution System from 1886-1901. B. C. Adkins. Describes the growth of the system, and its maintenance. Ill. 1200 w. Fire & Water—June 15, 1901. No. 41637.

Storage.

Storage Water Supplies. L. J. LeConte. On the importance of the greater relative value of run-off records, as compared with the annual rainfall records, in calculating the catchment water from any given watershed. 700 w. Am Water Wks Assn—June, 1901. No. 41952 C.

Valuation.

The Valuation of the Works of the Contra Costa Water Company. Review of a decision by a California court, in which the property of a company without an exclusive franchise and without power to fix its own charges for water, is valued at about 2½ times its cost of construction. 800 w. Eng Rec—June 1, 1901. No. 41338.

Waste.

The Restrictive features to Guard Against Waste Water. S. J. Rosamond On the value of self-closing fixtures where meters are not in use. 1200 w. Am Water Wks Assn—June, 1901. No. 41935 C.

Water Diversion.

Proposed Compensation in Kind for Water Diverted for the Supply of Norwich, Conn. Hill, Quick & Allen. Outlines a plan for compensating mill-owners for diverted water by supplying them with stored water in times of drouth. 2000 w. Eng News—May 23, 1901. No. 41207.

Water Economy.

An attempt to Prove That Thrift in the Operation of Water Works Is More Economical Than Waste. Clemens Herschel. Urging the selling water for domestic uses by measure, and giving information bearing on this subject. 4500 w. Am Water Wks Assn—June, 1901. No. 41934 C.

Water Ram.

Water Ram Utilized. G. T. Lotta. Describes the writer's method of utilizing the water ram to elevate water to a barn on a large stock farm located on very high ground. 400 w. Am Water Wks Assn—June, 1901. No. 41931 C.

Water Sanitation.

On the Rise and Progress of Water-Supply Sanitation in the Nineteenth Century. William T. Sedgwick. Discusses the advancement made, the past troubles of lead poisoning, impure water as a cause of disease, opinions of experts, various supplies, etc. 1000 w. Jour N. E. Water Wks Assn—June, 1901. No. 41381 F.

MISCELLANY.

Business Relationship.

Clients, Engineers, and Contractors. An editorial discussion of the legal rights in the business relations, and the extent of the engineer's authority. 3000 w. Engng—April 19, 1901. No. 40645 A.

Contracts.

American Contractors and British Contracts. Editorial on Sir Alfred Hickman's remarks in the House of Commons regarding the American railway contracts for India, and Lord George Hamilton's reply. 2500 w. Engng—June 7, 1901. No. 41610 A.

Engineers' Fees.

The New Schedule of Fees of German Architects and Engineers. Translation of the schedule adopted by most of the leading German architectural and engineering associations. The first installment gives the principles on which the schedule is based and the directions for computing architects' fees. 2200 w. Eng Rec—May 18, 1901. Serial. 1st part. No. 40965.

Rainfall.

The Causes of Rainfall. Prof. W. M. Davis. An explanation of the causes, and reasons for believing the artificial production of rain impossible. General discussion. 6300 w. Jour N. E. Water Wks Assn—June, 1901. No. 41382 F.

ECONOMICS AND INDUSTRY

ECONOMICS AND INDUSTRY.

Association.

Constitution of the National Metal Trades' Association. A copy of the revised constitution as amended at the N. Y. meeting. 4400 w. Ir Trd Rev—June 20, 1901. No. 41690.

Export Traffic.

The Dangers of the St. Lawrence Route for Export Traffic. Extracts from an article in the *N. Y. Tribune* setting forth the dangers to navigation and needed improvements, with editorial comment. 2300 w. Eng News—May 16, 1901. No. 40946.

Japan.

Japan, Our Latest and Greatest Rival for Commercial Supremacy in the Far East. Alexander Hume Ford. The present aticle considers the recent transition in Japan, her importance as a nation, her progress in the world's trade, and matters of related interest. 2800 w. Ir Age—May 2, 1901. No. 40658.

Labor.

The Relations of Capital and Labor. Herman Justi. An address delivered under the auspices of the Federation of Labor on Labor Day, at Springfield, Ill. 2300 w. Mines & Min—June, 1901. No. 41476 C.

Money Metals.

An Inquiry Into the Money Metals. Abstracted from reports by William Jacobs. Concerning the consumption of the precious metals in the world before the reign of the Emperor Augustus of Rome. 2000 w. Min Rept—May 30, 1901. Serial. 1st part. No. 41330.

Rival Ports.

Genoa and Marseilles. An explanation of the relative position of these two shipping centers. 1800 w. Engr, Lond—April 19, 1901. No. 40653 A.

Russia.

Russia as a Market for Machinery and Machine Tools. A. H. Ford. A review of present condition of the machinery trade in Russia, with especial reference to the disadvantageous position of the United States. 3000 w. Engineering Magazine—July, 1901. No. 41772 B.

Steel Trade.

President Schawb Before the Industrial Commission. An interesting report of testimony given. 9800 w. Ir Age—May 16, 1901. No. 40914.

The Federal Industrial Commission. Reports the testimony of three prominent men in the iron and steel business, chosen as representatives of the independent interests. 8200 w. Ir Age—May 23, 1901. No. 41053.

Strikes.

Strikes Ancient and Modern. Albert Stritmatter. Reviews early strikes in the United States, and gives table showing the increase. 1700 w. Am Mfr—June 6, 1901. No. 41542.

The Dayton Strike. An account of the troubles at the works of the National Cash Register Company. 2300 w. Ir Age—May 30, 1901. No. 41422.

The Machinists' Strike. A statement of the changed conditions, with editorial. 12600 w. Ir Age—June 6, 1901. No. 41424.

The Machinists' Strike in the United States. An editorial commentary upon the situation based upon the opinions of a number of leading employers. 2000 w. Engineering Magazine—July, 1901. No. 41779 B.

The Machinists' Strike. Reports from all sections of the country. 10500 w. Ir Age—May 30, 1901. No. 41423.

Trusts.

How Trusts Affect Prices. Jeremiah W. Jenks. A study of the results of combination on the distribution of wealth; the savings effected, and who receives the benefit. 4800 w. N Am Rev—June, 1901. No. 41332 D.

Wages.

The Economic Status of Wages. Edward Howell Putnam. A discussion of this subject, especially as applied to foundry work. 5400 w. Jour Am Found Assn—June, 1901. No. 41323.

ELECTRICAL ENGINEERING

COMMUNICATION.

Alternating Currents.

The Application of Alternating Currents to Cable Telegraphy (Darf Man die Theorie Rein Sinusformiger Wechselströme in Fragen der Kabeltelegraphic Anwenden?). Dr. F. Breisig. A comparison of the electrical transmission of power, with the possibility of telegraphing with similar currents. 4500 w. Elektrotech Zeitschr—May 16, 1901. No. 41742 B.

Berliner Patent.

The Berliner Telephone Patent Decision. The full text of Judge Brown's de-

cision. with illustrations. 40000 w. Elec Wld & Eng—June 29, 1901. No. 41901.

Cables.

A Graphic Method for Calculating the Distance of a Break in a Submarine Cable. E. Jona. An explanation of method with a table of values to save calculation. 1200 w. Electric, Lond—June 21, 1901. No. 41903 A.

Localization of High Resistance Breaks. J. Rymer-Jones. An explanation of a test devised by the writer. 3200 w. Elec Rev, Lond—June 7, 1901. Serial. 1st part. No. 41628 A.

Improvements.

The Latest Triumphs of Electrical Invention. Joseph S. Ames. Discusses the recent work of Marconi, Tesla and Pupin. 3700 w. Am Rev of Revs—June, 1901. No. 41335 C.

Phonograph.

See Electrical Engineering, Electrochemistry.

Printing Telegraph.

A New Page-Printing Telegraph. Discussion of paper by William B. Vansize. 8700 w. Trans Am Inst of Elec Engrs—May, 1901. No. 41605 D.

Space Telegraphy.

Experiments in Wireless Telegraphy with the Guarini Automatic Repeater. Gives the report laid before the Paris Congress, Sept., 1900, in regard to land communication, and then a summary of recent results of experiments by M. Guarini, between populous towns. 1500 w. Elec Rev, Lond—May 24, 1901. Serial. 1st part. No. 41353 A.

Variable Transmitters for Wireless Telegraphy (Ueber Einige Sendervariauten für Drahtlose Telegraphie). Dr. F. Braun. Discussing the various methods of turning transmitter and receivers to obtain varied syntonism. 1500 w. Elektrotech Zeitschr—June 6, 1901. No. 41752 B.

Wireless Telegraphy. Reginald A. Fessenden. Compares some of the results obtained by the U. S. Weather Bureau, with those of Marconi, noting where they go along parallel lines, differences in methods and results as published, and also work not known to have been duplicated. 2600 w. Elec Wld & Engr—June 29, 1901. No. 41899.

Telegraphy.

The Application of Storage Batteries to Railway Telegraph Service. W. E. Athearn. Extracts from a paper read before the Ry Tel Supts' Assn. Points drawing the economy of such installations and the care needed. 1200 w. Elec Rev, N. Y—July 6, 1901. No. 42017.

The Importance in Telegraphy of Apparently Little Things. Thomas D. Lockwood. Extracts from a paper read before the Ry Tel Supts' Assn. Considers points relating to the conductor and instruments and also the batteries. 1800 w. Elec Rev, N. Y—July 6, 1901. No. 42015.

Telegraphone.

The Telegraphone. An illustrated description of the remarkable recording telephone invented by Herr Poulsen. 1500 w. Nature—June 20, 1901. No. 41909 A.

Telephone Exchange.

Scranton's New Independent Telephone Exchange. Kempster B. Miller. Illustrated detailed description of the new independent telephone exchange. 3000 w. Elec Wld & Engr—June 8, 1901. No. 41549.

Telephony.

A Comparison of the Bell and Independent Systems and Methods of Operation. R. Max Eaton. Discusses the methods of both companies and the telephone problem generally. 1700 w. Elec, N. Y.—June 19, 1901. No. 41687.

A European Study of American Telephone Statistics. G. De La Touanne. A discussion of the statistics of the American Bell Telephone Co. 1900 w. Elec Wld & Engr—June 8, 1901. No. 41544.

Batteries Used in Telephony. P. Kerr Higgins. The present article treats of the primary battery, and the requirements of a good primary cell, descibing several forms. Ill. 3000 w. Elec, N. Y.—June 12, 1901. No. 41573.

Note on a Humming Telephone. F. Gill. A record of experiments showing the behavior of the humming telephone. 2000 w. Elec Rev, Lond—May 31, 1901. No. 41490 A.

Judge Thomas on Independent Telephony. His views on the growth and strength of the independent movement. 3500 w. Elec Wld & Engr—June 8, 1901. No. 41550.

Rights of Abutting Owners as Against Telephone and Telegraph Companies. G. C. Hamilton. From the *Central Law Journal*. Discusses some of the questions that have been raised and the opinions rendered. 2500 w. Elec Rev, N. Y.—May 4, 1901. No. 40772.

Telephone Exchange Service. L. W. Stanton. Read before the Ind. Telephone Con. Discusses the importance of good apparatus in securing reliability, promptness and good transmission. 2500 w. Elec Rev, N. Y—July 6, 1901. No. 41018.

The Telephone in Railroad Service. F. P. Valentine. Read before the Assn of Ry. Tel. Supts. Discusses the advantage of the use of the telephone in this work and how to obtain the best results. 3200 w. R R Gaz—July 5, 1901. No. 42065.

Village Exchanges and Farmers' Lines. S. P. Sheerin. Read at Buffalo meeting of Ind. Tel. Assn. Considers some points in connection with country lines. 3300 w. Elec, N. Y—July 3, 1901. No. 41954.

Writing Telegraph.

The Electrograph—A New Facsimile Telegraph. Illustrates and describes an instrument on exhibition at the Pan-American, in the U. S. Patent Office exhibit, which is a decided advance on other facsimile telegraphs. 1500 w. Sci Am—June 15, 1901. No. 41587.

The Telautograph. Illustrative description of the Foster Ritchie writing telegraph, and its operation. 1400 w. Nature—May 30, 1901. No. 41482 A.

DISTRIBUTION.

Computation.

The Application of the Cord Polygon to the Computation of Current Distribution (Die Anwendung des Seilecks für die Berechung der Stromveltheilung). Ph. Pforr. An application of the methods of graphical statics to electrical current distribution for tramways. 4000 w. Elektrotech Zeitschr—May 16, 1901. No. 41741 B.

Controller.

Improved Controller for Polphase Currents (Neue Drehstrom Kontroller). W. Ephraim. Diagrams and views of the controller of the "Helios" Company, for use with polyphase motors. 1200 w. Elektrotech Zeitschr—June 6, 1901. No. 41750 B.

Currents.

Capacity Currents as Influenced by Frequency. T. Mather. Gives results of experiments made on the influence of frequency on capacity currents supplied by a machine having a somewhat peaked E. M. F. wave, showing the wave forms of current and P. D. actually obtained. 1700 w. Elec Rev, Lond—May 31, 1901. No. 41486 A.

Pressure.

Pressure of Supply. Arthur C. F. Webb. Comparisons between the rapidly disappearing 100-volt pressure and the more modern 200 to 230 volts pressure. 1700 w. Aust Min Stand—May 2, 1901. No. 41523 B.

ELECTRO-CHEMISTRY.

Accumulators.

See Electrical Engineering, Generating Stations.

See Mechanical Engineering, Automobilism.

Acetylene.

The Electrochemical Behavior of Acetylene (Ueber das Elektrochemische Verhalten des Acetylens). Dr. H. von Steinwehr. A discussion of the possibilities of acetylene in organic synthesis. 1200 w. Zeitschr f Elektrochemie—June 6, 1901. No. 41754 G.

Address.

Electro-Chemical Industries. A. H. Jackson. Abstract of a lecture delivered before the Victorian Society of Chemical Industry. 1900 w. Aust Min Stand—May 2, 1901. Serial. 1st part. No. 41524 B.

Bleaching.

Bleaching by Electricity. George E. Walsh. Briefly reviews the methods, showing the advancement made. 1000 w. Elec Rev, N. Y.—June 15, 1901. No. 41657.

Diaphragms.

Concerning Diaphragms (Ueber Diaphragmen). Dr. M. Le Blanc. A paper before the German Electrochemical Society discussing the action of various kinds of diaphragms used in connection with electrolytic work. 3500 w. Zeitschr f Electrochemie—May 30, 1901. No. 41753 G.

"Dry Cells."

Experiments with Commercial "Dry Cells," for Secondary Standards of E. M. F. Henry St. John Hyde. An account of experiments made in the Physical Laboratory of Columbia Univ. in order to ascertain the constancy of the E. M. F. under varying conditions. 2500 w. Sch of Mines Qr—April, 1901. No. 41672 D.

Laboratory.

The Electrochemical Laboratory at Owens College. R. S. Hutton. Illustrates and describes the new Physical Laboratories of the Owens College, Manchester, Eng., which are equipped for electrochemical and especial electrometallurgical work. 1800 w. Elec Chem & Met—May, 1901. No. 41484 A.

Mercury Process.

The Mercury Processes for the Production of Caustic Alkalies and Chlorine. John B. C. Kershaw. Gives details concerning the present position of the non-diaphragm mercury processes. Ill. 1300 w. Elec, N. Y.—June 5, 1901. No. 41400.

Phonograph.

A New Phonographic Principle. W. Nernst and R. von Lieben. From the *Zeitschrift für Electrochemie*. Explains the principle of a new phonograph, in which the electrochemical action of a current upon an endless platinum band enables variations of current to be reproduced in a microphone. 3500 w. Elect'n, Lond—June 7, 1901. No. 41635 A.

ELECTRO-PHYSICS.

Condensers.

Some Notes on Dielectric Losses. Charles Proteus Steinmetz. Gives results of some determinations of the loss of power in electrostatic condensers on an alternating-current circuit, and at various frequencies and voltages. 800 w. Elec Wld & Engr—June 22, 1901. No. 41868.

The Influence of a Non-Inductive Resistance on the Oscillatory Discharge of a Condenser. T. Mizuno. Mathematical demonstration. 600 w. Elect'n, Lond—May 24, 1901. No. 41357 A.

Hysteresis.

Distribution of Hysteresis in a Plate of Sheet Iron (Verlauf des Hysteresiskoëfficienten innerhalb einer Blechtafel). Dr. G. Stern. Detail of measurements at various places in a piece of sheet iron are given, showing the variations. 2000 w. Elektrotech Zeitschr—May 23, 1901. No. 41745 B.

Nickel.

Note on Nickel at High Temperatures. Albert Campbell. Gives results of some experiments in connection with a hot wire current regulator. 300 w. Elec Rev, Lond—June 14, 1901. No. 41825 A.

Permeability.

An Instrument for Measuring the Permeability of Iron and Steel. C. G. Lamb and Miles Walker. Read before the Inst. of Elec. Engrs. Illustrates and describes an instrument designed to meet the demand for a simple, cheap and reliable piece of apparatus for this use. 3700 w. Elect'n, Lond—June 7, 1901. No. 41636 A.

Radiography.

New Process of Pelvimetry and Long Distance Radiography. From *La Nature*. An illustrated account of investigations made by Dr. Varnier, the results of which promise to be of value to physicians. 900 w. Sci Am Sup—May 11, 1901. No. 40900.

On Anode Rays. W. Hibbert. Observations noted during a series of experiments on the absorption of X rays by various salts and metals. Ill. 900 w. Elec Rev, Lond—June 7, 1901. No. 41629 A.

Wave Photography.

Photography of Alternating-Current Waves by the Braun Tube (Demonstration und Photographie von Wechselstromkurven mittels der Braunischen Rohre). A. Weinhold. With reproductions of photographs of monophase, biphase, and triphase waves. 2500 w. Elektrotech Zeitschr—May 16, 1901. No. 41740 B.

GENERATING STATIONS.

Accumulators.

A general Study of the Storage Battery as a Load Equalizer (Die Pufferbatterie im Allgemeinen). O. Hoppe. An examination of the advantages of the storage battery as an equalizer of the load, with reference to the power plant at Thiede, near Brunswick. 6000 w. 1 plate. Glückauf—June 1, 1901. No. 41733 B.

Installation, Operation and Economy of Storage Batteries. Ernest Lunn. Considers the battery plant of the Edison Illuminating Co., of Detroit, Mich., giving also a description of the cell most commonly used in lighting and power stations. Ill. 5000 w. Jour Assn of Engng Socs—April, 1901. No. 41291 C.

Storage Batteries in Electric Power Stations, Controlled by Reversible Boosters. J. S. Highfield. Read before the Inst. of Elec. Engrs., England. Discusses what seems to be the chief points in considering the designing of batteries for the work in central stations, and describes the subsidiary apparatus which may be found of use and convenience in operating batteries. 4000 w. Elec Rev, Lond—June 14, 1901. Serial. 1st part. No. 41826 A.

The Storage of Electricity. A. H. Allen. Read before the Civ. & Mech. Engrs. Soc. Considers the application of storage batteries to complete storage, partial storage, and fly-wheel storage. Ill. 3300 w. Engr, Lond—May 31, 1901. Serial. 1st part. No. 41498 A.

Alternators.

The Influence of Circumferential Velocity Upon the Dimensions and Weight of Alternators (Ueber den Einfluss der Umfangsgeschwindigkeit auf die Dimensionen und Materialgeuricht von Drehstromgeneratoren). A. Siewert. With computations of weights and dimensions in comparative cases. 3000 w. Elektrotech Zeitschr—June 6, 1901. No. 41749 B.

Armatures.

The Resistance of Short-Circuited Armatures (Der Wilderstand des Kurzschlussankers). J. Heubach. Deriving formulas for the computation of the resistance, with diagrams showing the relations of the line curves. 3000 w. Elektrotech Zeitschr—May 23, 1901. No. 41744 B.

The Winding of Closed Coil Drum Armatures. William Beckit Burnie. Explains how it is possible to get all the formulæ commonly used for driven armatures from one single expression. 2300 w. Elect'n, Lond—May 31, 1901. No. 41480 A.

Central Stations.

The Central Station Boiler Room. William D. Ennis. A discussion of points essential to the securing of economical and satisfactory results. 3000 w. Am Elect'n—July, 1901. No. 41971.

Converters.

Starting Rotary Converters. Arthur B. Weeks. Gives directions for starting, and notes on other points relating to rotaries. Ill. 2400 w. Am Elect'n—July, 1901. No. 41975.

Chaudiere Falls.

Chaudiere Falls Power Transmission Plant. R. Girouard. An illustrated account of the hydraulic development, transmission line, power house and sub-stations. 1200 w. Elec Wld & Engr—June 15, 1901. No. 41664.

Dynamos.

Faults in Dynamos. Lamar Lyndon.

Discusses the chief irregularities to which dynamos are subject and their causes and remedies. 2500 w. Marine Engng—July, 1901. Serial, 1st part. No. 42013 C.

Magnetic Attraction in Dynamos Due to the Armature and Field being Non-concentric. Edgar Knowlton. Gives a fairly accurate method of calculating the magnetic attraction for a specified displacement. Mathematical. 1200 w. Elec Wld & Engr—June 8, 1901. No. 41547.

Energy Diagrams.

Energy Diagrams of Small Electric Lighting Plants. Illustrated description of a graphical method of indicating the transformation of energy in two small stations. 800 w. Eng Rec—June 15, 1901. No. 41561.

Fuel-Gas Plant.

A Fuel Gas Plant for a Model Isolated Hospital in England. Illustrated description of the plant for six hospital buildings at Shingford. 1300 w. Elec Wld & Engr—June 1, 1901. No. 41405.

Generating Set.

Generating Set of 830 Kilowatts (Groupe Electrogène de 830 Kilowatts). The group, exhibited at Paris, consisted of a 1200 h. p. compound Corliss engine by Crépelle & Garand, of Lille, and two dynamos of 415 kw. each, one on each side of the fly wheel. 1000 w. Génie Civil—June 8, 1901. No. 41706 D.

Glasgow Exhibition.

Steam Electric Generating Plant at the Glasgow Exhibition. Review of the exhibit of boilers, engines and electric generators. 3700 w. Engng—June 14, 1901. Serial. 1st part. No. 41834 A.

Ilford, Eng.

Ilford Electricity Works. Illustrated detailed description. 3300 w. Elec Engr, Lond—May 24, 1901. No. 41356 A.

Isolated Plant.

An Isolated Plant at Nassau, Bahama Islands. An illustrated description of the power house and equipment which provides two hotels with light, power, steam and ice. 2300 w. Elec Wld & Engr—June 1, 1901. No. 41403.

Joint Works.

The Kensington and the Notting Hill Companies' Joint Electricity Works. An account of joint generating works erected at a cost of £100,000. Ill. 2800 w. Elec Rev, Lond—June 21, 1901. Serial. 1st part. No. 41912 A.

Lachine Rapids.

The Lachine Rapids Power Plant. An illustrated description of the works, construction of the dams, weirs, gates, turbines, and power houses; also, the switchboard equipment. 6800 w. Can Engr—June, 1901. No. 41570.

Madrid.

The Reconstruction of the Electric Station at Madrid Spain (Umbau des Elektricitäts werkes der Electricity Supply Co. for Spain, Ltd., Madrid). H. Baswitz. An illustrated description of the new plant, giving details of generators, transformers, and distribution. 3000 w. Elektrotech Zeitschr—May 23, 1901. No. 41743 B.

Manchester, N. H.

Electrical Development at Manchester, N. H. Illustrated detailed description of the novel condition made possible by the consolidation of electrical supply interests, by which a single sub-station receives electrical energy from five generating plants and distributes it in four different towns. 4500 w. Elec Wld & Engr—May 25, 1901. No. 41283.

Mountain Stations.

Electric Plants in the Mountains. Describes plants whose design depended on the facilities for transporting the parts to the site of the stations; burros, rope-ways and wagon roads furnishing the basis of classification of the different designs. 2200 w. Eng Rec—June 15, 1901. No. 41560.

Newcastle-on-Tyne.

A Water Power Railway Plant with Electric Power Supply at Newcastle-on-Tyne. An illustrated detailed account of this undertaking for supplying electric power "in bulk." 5000 w. Elect'n, Lond—June 21, 1901. Serial, 1st part. No. 41902 A.

The Beginning of Electric Power Distribution. An illustrated description of the first three-phone electric power supply system in Great Britain. The inauguration of the station at Neptune Bank in Wallsend. 4300 w. Lightning—June 20, 1901. No. 41908 A.

Niagara.

How Niagara Has Been "Harnessed." William C. Andrews. Considers the production of the electricity at the generator and its transmission to Buffalo. 2700 w. Am Rev of Revs—June, 1901. No. 41-334 C.

Pan-American.

Niagara Falls Power Development and the Pan-American Expositon. Orrin E. Dunlap. An illustrated detailed description of features of the power plant, and the transmission of the power for exposition use. 4600 w. W. Elect'n—May 18, 1901. No. 41033.

Polyphase Plant.

On Polyphase Generating and Sub-Station Plant for Electric Traction. A. C. Eborall. Discusses points in a recent paper by H. M. Hobart. 2300 w. Elec Rev, Lond—June 1, 1901. Serial. 1st part. No. 41630 A.

Railway Plant.

Alternating-Current Transmission. Illustrated description of the transmission plant and sub-stations of the Kalamazoo Valley Electric Company. 1400 w. Am Elect'n —July, 1901. No. 41970.

The Electric Installations of the Western Railway of France (Les Installations de la Compagnie des Chemins de Fer de l'Ouest). E. Cappeau. A description of the plant for lighting, miscellaneous power, and for the traction on the Paris-Versailles line. Serial. Part I. 2500 w. Revue Technique—May 10, 1901. No. 41709 D.

Rotherham.

Rotherham Electricity Works. An illustrated description of English works, recently inaugurated. 3000 w. Elec Engr, Lond—May 31, 1901. No. 41491 A.

Steamship Plant.

Electric Light and Power Installation on Steamer "Deutschland." Illustrated detailed description of this very fine plant. 1700 w. Elec Wld & Engr—June 1, 1901. No. 41402.

Traction Plant.

Choice of Type and Periodicity for Electric Traction Plant. H. M. Hobart. Thinks the rotary converter should be superseded by the motor generator, and the periodicity should be still further lowered for the case of very slow speed steam engines; but it may be advantageous to employ rotary converters, and at 25 cycles per second, for plants where the generators are direct connected to high-speed engines. 1100 w. Elec Rev, Lond—May 24, 1901. No. 41354 A.

Transformers.

Testing Large Transformers. John S. Peck. Describes the transformers recently installed by the Cataract Power and Conduit Co., of Buffalo, N. Y., and the methods of testing them. Ill. 2500 w. Elec Wld & Engr—June 22, 1901. No. 41871.

Tynemouth.

Tynemouth Electficity Works. Illustrated detailed description of a plant for electric light and traction at an English health resort. 2700 w. Elec Engr, Lond —June 7, 1901. No. 41631 A.

Wigan.

Wigan Corporation Electric Supply and Tramway Works. Illustrated detailed description. 1500 w. Elect'n Lond—June 7, 1901. No. 41632 A.

LIGHTING.

Arc Lighting.

Arc Lighting at the Beginning of the Twentieth Century. H. W. Hillman. Read before the Nat. Elec. Lgt. Assn. Discusses the reasons for adopting the alternating system of street lighting at Atlanta, and the subject generally; the operation, cost and methods. Ill. 3700 w. Elec Rev, N. Y—June 8, 1901. No. 41552.

Arcs.

The Behaviour of Continuous Current Arcs (Neue Wirkungen des Gleichstromlichtbogens). W. Penkert. With especial reference to the musical arcs of Simon and of Duddell, giving computations of the periods of vibration. 2500 w. Elektrotech Zeitschr—June 6, 1901. No. 41751 B.

Dimming.

A Cheap Method of Dimming Lamps (Eine Billige Methode der Lampenverdunkelung). P. Stern. Two lamps are used either in parallel or in series, the latter arrangement being used when diminished illumination is desired. 1200 w. Elektrotech Zeitschr—May 30, 1901. No. 41748 B.

Lamps.

From Cotton-Wool to Candle-Power. Describes a visit to an English glow-lamp factory. Ill. 2400 w. Lightning—May 30, 1901. No. 41483 A.

Pan-American.

Artistic Effects of the Pan-American Exposition. Ernest Knaufft. An illustrated account of the fine effects produced by electric lighting. 3300 w. Am Rev of Revs—June, 1901. No. 41333 C.

Searchlights.

The Modern Searchlight in the Navy. Frank C. Perkins. Illustrated descriptions of some searchlights in use and the methods of operating. 1500 w. Elec, N. Y—June 5, 1901. No. 41401.

Vapor Lamps.

Mr. P. Cooper Hewitt's New Mercury Vapor Lamp. Legh S. Powell. An account of an experiment made, illustrating the apparatus used, during which similar effects were observed as early as 1885. Also an article explaining the theory of this lamp. 2800 w. Elec Rev, Lond—May 24, 1901. No. 41355 A.

MEASUREMENT.

Alternate Currents.

On Test-Room Methods of Alternate-Current Measurement. Albert Campbell. Abstract of a paper read before the Inst. of Elec Engrs., England. Describes a number of methods of measurement, some of which are capable of fairly general application, while others are only of use in special cases. 2000 w. Elect'n, Lond—June 7, 1901. Serial. 1st part. No. 41634 A.

Electric Balance.

A Sensitive Electrical Balance (Sur une Balance Très Sensible Pouvant Servir de Galvanometre, d'Electrodynamometre et d'Electromètre Absolu). V. Crenneu. Describing a modification of M. Lipp-

mann's astatic galvanometer. 1000 w. Comptes Rendus—May 28, 1901. No. 41-738 D.

Galvanometer.

A Perfectly Astatic Galvanometer (Sur un Galvanometre Parfaitement Astatique). M. Lippman. The needle is so suspended as to be displaced parallel to itself by the action of the current. 1000 w. Comptes Rendus—May 13, 1901. No. 41737 D.

Meter.

A Watt-Hour Meter. Frank Holden. Read before the Inst. of Elec. Engrs. Describes the Frazer meter, showing its defects, and using it for comparison in describing the meter which is the subject of this paper. Ill. 2600 w. Elect'n, Lond—May 24, 1901. Serial. 1st part. No. 41-358 A.

POWER APPLICATIONS.

Coal Handling.

Electric Coal Handling Plant at the Harbor of Rotterdam (Elektrisch Betriebene Kohlenkippe für den Hafen von Rotterdam). A very full account of the harbor improvements at Rotterdam, with illustrations of the plant by which the extensive coal trade is handled. Serial, Part I. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 8, 1901. No. 41-716 D.

Coke Plant.

The Electric Installation at the Orlau-Lazy Coke Ovens (Die Elektrische Anlage in der Koks anstalt Orlau-Lazy). A. Hartmann. With illustrations of the extensive coke handling plant in Austrian Silesia, including electrically driven charging, handling, and washing machinery. 1800 w. Elektrotech Zeitschr—May 30, 1901. No. 41746 B.

Cranes.

See Mechincal Engineering, Machine Works and Foundries.

Diamond Drill.

See Mining and Metallurgy, Mining.

Dry Dock.

The Largest Electrically Operated Dry Dock in the World. An illustrated description of the recently completed electric dry-dock of South Brooklyn, N. Y. 1200 w. Elec Wld & Engr—June 22, 1901. No. 41867.

Ingot Stripper.

An Electric Ingot Stripper. An illustrated description of the machine in use at the Worcester (Mass.) Works of the American Steel and Wire Co., and the method of operating. 2600 w. Ir & Coal Trds Rev—June 7, 1901. No. 41606 A.

Motors.

A Rotary Field Electrostatic Induction Motor. Prof. Hidetaro Ho. The non-mathematical portion of a paper from the *Journal of the Inst. of Elec. Engrs.*, of Tokyo, Japan. Illustrated description. 1600 w. Elec Wld & Engr—June 15, 1901. No. 41665.

Self-Starting Single-Phase Motor Without Brushes. J. Fischer-Hinnen. Illustrated description of a motor where the current distribution in the armature required for starting is effected by means of induction, doing away entirely with the brushes. 800 w. Elec Wld & Engr—June 22, 1901. No. 41869.

The Computation of the Stray Co-efficient in Induction Motors (Ueber die Berechnung des Streuungsfaktors Asynchroner Motoren). J. Jonas. Deriving formulas for the coefficients of the stator and the rotor in terms of the e. m. f. of the respective fields. 3500 w. Elektrotech Zeitschr—May 30, 1901. No. 41747 B.

The Polyphase Induction Motor for General Power Service. Ralph D. Mershon. Presents the merits of the induction motor for general power service and corrects misconceptions which exist concerning it. 2500 w. Elec Wld & Engr—June 8, 1901. No. 41546.

Parallel Driving.

Notes on the Theory of Synchronous Motors and of Alternators in Parallel. Alexander Russell. A sketch of the elements of the mathematical theory of the synchronous motor and of alternators in parallel, illustrating the results by means of curves. 2000 w. Elec Rev, Lond—May 31, 1901. Serial. 1st part. No. 41488 A.

Power Supply.

Power Supply from Alternating Current Stations. Gives a solution of this problem which has been tried and found very successful. 2500 w. Elec Rev, Lond—May 31, 1901. No. 41487 A.

Pumping Plant.

See Mining and Metallurgy, Mining.

Rock Drills.

Practical Trials with Rotary Electric Rock Drills. C. Schraml, in *Oesterreichische Veitschrift für Berg-und Hüttenwesen.* Report of trials and illustrated description of drills used. 1800 w. Col Guard—June 7, 1901. No. 41616 A.

The Development of Electrically Driven Rock Drills (Ueber die Entwicklung der Gesteinsdrehbohrmaschinen mit Elektrischem Antriebe). C. Schraml. A review of recent progress, with description of the machines of the Union Electric Co., Siemens & Halske, and Bornet. Two articles, 5000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 18, 25, 1901. No. 41734 each B.

TRANSMISSION.

High Potential.

The Transmission of Current at High

Potential in New York City. Calvin W. Rice. Read at convention of Nat. Elec. Lgt. Assn. Also editorial. An interesting resumé of high voltage power transmission as practiced in New York, giving practical information underground work in this field. 3500 w. Elec Wld & Engr—May 25, 1901. No. 41282.

Line.

A 4,427-foot Span in an Electric Transmission Line. Illustrates and describes an interesting feature of the line of the Bay Counties Power Company, of San Francisco, whereby high tension electrical energy is carried across navigable tide-water, 200 feet above high-water level. 2700 w. Eng Rec—June 22, 1901. No. 41872.

Spanning Carquinez Straits with a High-Potential Transmission Line. R. H. Sterling. An illustrated description of an aerial crossing at the point named and the method of construction. 1400 w. Elec Wld & Engr—June 8, 1901. No. 41545.

Los Angeles.

Los Angeles Transmission Plants. Deals mainly with the two large plants, giving results of operation. 2000 w. Elec Wld & Engr—June 22, 1901. No. 41870.

MISCELLANY.

Accidents.

Electric Accidents and the Means of Preventing Them. L. W. de Grave. Abstract of a paper read before the Chesterfield & Midland Co.'s Inst. of Engrs. Discusses the causes and considers accidents usually due to gross carelessness. Also measures for protection and prevention. 2200 w. Col Guard—May 31, 1901. No. 41506 A.

Berlin.

The Coming Visit of the Institution of Electrical Engineers to Berlin. A series of brief illustrated descriptions of the works to be visited. The present article gives a sketch of the machine and apparatus works of the Allgemeine Elektricitäts-Gesellschaft. 1400 w. Elec Engr, Lond—April 26, 1901. Serial. 1st part. No. 40801 A.

Lightning.

The Protection of Buildings from Lightning. Alfred Hands. Read before the Architectural Assn., England. Briefly explains the electrical action during a thunderstorm, reviews the history of protection, and discusses the prevailing practice. Also discussion. 12600 w. Builder—May 18, 1901. No. 41238 A.

Rowland.

Henry A. Rowland. Cary T. Hutchinson. On the work done by him in applied electrical science. 2000 w. Elec Wld & Engr—May 4, 1901. No. 40789.

GAS ENGINEERING

Acetylene.

Analysis and Purification of Acetylene. Summary of an address, compiled by Herren A. Rossel and E. Landriset, delivered at the inauguration of the Swiss Carbide and Acetylene Association at Berne. 2500 w. Jour Gas Lgt—June 11, 1901. No. 41692 A.

See Electrical Engineering, Electrochemistry.

Address.

Inaugural Address Before the Incorporated Gas Institute, England. T. Ormiston Paterson. Reviews the difficulties met and conquered by the gas industry in the early part of the 19th century, and discusses the problems of the present. 5500 w. Jour Gas Lgt—June 11, 1901. No. 41691 A.

Benzol.

A New Test for Sulphur in Benzol for Use in Gas Works. Wilfrid Irwin. Read at the May meeting of the Manchester Section of the Soc. of Chem. Ind. Gives the usual methods employed for the determination, and also the author's method. 1100 w. Gas Wld—June 15, 1901. No. 41828 A.

Blast-Furnace Gases.

The Utilization of Blast Furnace Gases. A review of an address by M. J. Deschamps and the discussion that followed. 1400 w. Engr, Lond—June 7, 1901. No. 41614 A.

Electrolysis.

A French Opinion of Electrolysis of Pipes. Review of a report claiming that electrolysis will not occur where the difference in potential between pipes and rails is less than 1 to 1½ volts. 1600 w. Eng Rec—June 1, 1901. No. 41337.

Report of the Master in Chancery on the Peoria Electrolysis Litigation. Extracts from report filed with the U. S. Circuit Court at Chicago, stating that the pipes were being steadily injured by the return currents of the railways operated by the single trolley system. Also editorial on the effect of this report on electric railway investments. 5000 w. Eng Rec—June 15, 1901. No. 41562.

Fuel Gas.

Mond Fuel Gas in Great Britain. Gives the distinguishing features of the Mond process, and a technical description taken

from a paper by Mr. H. A. Humphrey. 1400 w. U S Cons Repts, No. 1063—June 15, 1901. No. 41600 D.

The Mond Gas Bill. An account of interesting facts and figures given in evidence before a Select Committee of the House of Commons. 3000 w. Engr, Lond—May 24, 1901. Serial. 1st part. No. 41362 A.

Fuel-Gas Plant.

See Electrical Engineering, Generating Stations.

Galveston Storm.

A Stormy Experience. John Gimper. Read before the Western Gas Assn. An account of the gas company's experience, having four gasholders destroyed, retort house, shop and warehouse, coal shed, governor house, fence wall and superintendent's dwelling. Discussion. 3000 w. Pro Age—June 15, 1901. No. 41555.

Gasholder.

Description of a Gasholder and Tank Erected at the Hull Station of the British Gaslight Company, with Some Practical Suggestions on Construction. Ill. 3600 w. Jour Gas Lgt—June 4, 1901. No. 41596 A.

Difficulties in Constructing a Concrete Gasholder Tank. Describes the method of building a large tank on a side hill in a clay soil which slipped badly. 2000 w. Eng Rec—June 8, 1901. No. 41464.

Gas Industry.

The Progressive Age. J. D. Ashworth. Read before the Inst. of Gas Engrs. The writer takes a rather depressed view, but gives some suggestions worthy of consideration. Discussion. 4000 w. Gas Wld—May 4, 1901. No. 40921 A.

Gas Machine.

Remarkable Behavior of a Naphtha Gas Machine in a Fire. E. P. Reichhelm. An illustrated description and explanation of the machine which withstood a fierce conflagration without exploding. 800 w. Am Mach—June 13, 1901. No. 41575.

Gas Users.

Business Outside the Usual Channel. F. W. Stone. Read before the Ohio Gas Lgt. Assn. Enumerates some of the uses to which gas may be applied. Also general discussion. Ill. 4000 w. Pro Age—May 1, 1901. No. 40700.

Hygienic Effect.

Gas and Hygiene. James Ferrier. Read at meeting of the Western Gas Assn. A discussion of what constitutes hygienic light and heat, and what should be the policy of the gas industry. Also general discussion. 10000 w. Am Gas Lgt Jour—June 10, 1901. No. 41554.

Incandescence.

High and Low Pressure Gas Incandescent Lighting. William Sugg. Read before the Inc. Gas Inst. The paper emphasizes the importance of the velocity of the gas, and illustrates the author's high-pressure apparatus. 3400 w. Gas Wld—June 15, 1901. No. 41831 A.

Self-Intensifying of Gas Pressure by Means of Waste Heat. C. Scott Snell. Discusses the conditions and gives an illustrated description of the author's invention—the Scott-Snell lamp. Also discussion of this paper, with the papers by Messrs. Sugg and Grafton. 14500 w. Gas Wld—June 15, 1901. No. 41833 A.

Some Notes on Incandescent Gas Lighting. Ernest Feardon. Read before the Manchester and Dist. Jun. Gas Assn. Introductory remarks on this means of producing light, with short descriptions of some of the lamps, and statements as to efficiency, cost, etc. 5000 w. Jour Gas Lgt—May 21, 1901. No. 41301 A.

The Effect of Quality and Pressure of Gas on the Efficiency of Incandescent Gas Lighting, Having Regard to Economy. Walter Grafton. Read at Inc. Gas Inst. meeting. Proposal to reduce the illuminating power of gas to 10 candles by adding air to the gas. 4300 w. Gas Wld—June 15, 1901. No. 41832 A.

The Theory of the Incandescent Gas Burner (Theorie des Gasglühlichtes). Franz Bössner. A discussion of the action of oxides of the metals of the earths in connection with the emission of light when heated. An important study of the incandescent mantle. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—May 31, 1901. No. 41720 B.

Japan.

Lights in Japan. An account of the recent development in house and street lighting, with illustrated description of work of Japanese gas-fitters. 1500 w. Am Gas Lgt Jour—May 20, 1901. No. 41028.

Photometer.

A New Table Photometer and Pentone Ten-Candle Lamp. Frank Clowes, On official gas testing in London, with illustrated descriptions of new apparatus, giving results obtained by its use. 4500 w. Gas Wld—June 15, 1901. No. 41829 A.

Purification.

The Purification of Blast-Furnace Gas. F. W. Lürmann, in *Stahl und Eisen.* Illustrated account of the arrangements in use at several large plants in Germany. 1200 w. Col Guard—May 24, 1901. No. 41372 A.

Selling.

Hints on Gas Selling. John Young. Read before the East. Co.'s Gas Mgrs. Assn. Suggestions of value to works managers, with discussion. 5500 w. Gas Wld—April 20, 1901. No. 40629 A.

Societies.

The Question of Amalgamation. J. W.

Helps. Read before the Inst. of Gas Engs. The story of the proposed amalgamation of the Institution of Gas Engineers, with the Gas Institute, with the discussion that followed. 14500 w. Gas Wld—May 4, 1901. No. 40916 A.

Street Lighting.

Common Sense in Street Lighting. Edward B. Ellicott. Read before the League of Ohio Municipalities. Gives some statistics relating to the cost of lighting with gas or gasoline lamps equipped with incandescent mantles, and discusses the subject generally. 2200 w. Pro Age—June 15, 1901. No. 41556.

Water Gas.

I. Why I Adopted Water Gas. William Longford. II. British Water Gas Practice. Robert Porter. Two papers presented at meeting of the Inc. Gas Inst. and discussed together, though most of the interest was in replying to Mr. Porter's paper. Ill. 21500 w. Gas Wld—June 15, 1901. No. 41830 A.

MARINE AND NAVAL ENGINEERING

Air Pumps.

Direct Driven Air Pumps. Illustrates and describes the direct driven air pumps adopted for the engines of the Denver class of U. S. cruisers. 400 w. Marine Engng—July, 1901. No. 42010 C.

Battleship.

Launch of the Battleship "Ohio." An illustrated description of the vessel, with some account of the yards in which it was built. 1800 w. Sci Am—June 8, 1901. No. 41451.

Boat Lowering.

The Welin Boat-Lowering Gear. Illustrated description. 700 w. Engng—June 21, 1901. No. 41925 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

The Romance of Applied Science in the United Kingdom. Reviews the record of the Inst. of Naval Architects, and the development of the shipbuilding industry. 2700 w. Ir & Coal Trds Rev—June 14, 1901. Serial. 1st part. No. 41843 A.

Bulkheads.

The Unsinkability of Ships (Eine Bemerkung über die Unsinkbarkeit der Seeschiffe). Guido Bocchi. A discussion of the proper location of bulkheads, so that the filling of compartments shall not endanger stability. 1800 w. Schiffbau—June 8, 1901. No. 41724 D.

Coaling Barge.

The Clarke Automatic Coaling and Weighing Barge. Illustrated detailed description of this barge for coaling steamers and its method of work. 3000 w. Ir Age—June 20, 1901. No. 41656.

Coaling Boat.

Ingenious Vessel-Coaling Boat. Full illustrated description of the Clarke automatic coaling and weighing barge. 4000 w. Naut Gaz—July 4, 1901. No. 41999.

Coaling Stations.

The Defence of Coaling Stations. S. Eardley-Wilmot. Arguments favoring the defence against sea attack being given to men with sea experience. 1600 w. Engrs Lond—June 21, 1901. No. 41927 A.

Compass Card.

Another Form of Compass Card. A proposal to embody both the degree system and the point system in one card, with a view to bringing about gradually the adoption of the former. 1200 w. Marine Rev—May 23, 1901. No. 41233.

Coppersmithing.

Coppersmithing, with Special Reference to Marine Practice. William Weigman. Suggestions of methods producing satisfactory results. Ill. 700 w. Marine Engng—June, 1901. No. 41533 C.

Corrosion.

A Simple Method of Preventing Corrosion of Tail Shafts. James M. Thornton. Read before the N. E. Coast Inst. of Engrs. & Shipbuilders. Illustrates the method the writer has adopted, by which tail shafts can be preserved and made to last for years without breaking. 1200 w. Engrs' Gaz—June, 1901. No. 41481 A.

Cruisers.

The New Russian High-Speed Cruisers. Facts concerning the four new cruisers ordered, which follow exactly the lines laid down for the Bogatyr. Elevation, deck plan and cross-section are given. 1700 w. Engng—May 24, 1901. No. 41369 A.

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The New Floating Drydock for the United States Navy. Illustrated detailed description of this steel floating drydock, now nearing completion, to be located at Algiers, La. 1700 w. Sci Am—June 15, 1901. No. 41589.

Education.

Schools of Marine Engineering and Naval Architecture. George Crouse Cook. Illustrated account of the facilities for study at the Engineering College of the Imperial University of Tokyo, Japan. 3200

w. Marine Engng—July, 1901. No. 42012 C.

India.

River Steamers and Inland Navigation in India. Information concerning the improvements made in the river steamers since the days of the pioneer vessels. Ill. 2000 w. Ind & East Engr—May, 1901. Serial. 1st part. No. 41595 B.

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The Application of the Steam-Engine Indicator to Rowing. C. M. Allen. Illustrated description of the apparatus used, with analyses of the cards taken, and the results. Ill. 2500 w. Jour Worcester Poly Inst—May, 1901. No. 41068 C.

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On the Use of Liquid Fuel in Sea-Going Merchant Steamers. E. L. Orde. Read before the N. E. Coast Inst. of Engrs. and Shipbuilders, at Sunderland, England, Discusses the possibilities of the fuel and the merits of the different classes of apparatus used. 2800 w. Marine Engng—July, 1901. No. 42007 C.

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The Examination of Sea-Going Engineers. Editorial review of the alterations in the new regulations initiated by the British Board of Trade. 1300 w. Engng—May 24, 1901. No. 41370 A.

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See Mechanical Engineering, Steam Engineering.

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Address Before the National Association of Manufacturers. Theodore C. Search. Extract referring to the upbuilding of the American merchant marine. 4000 w. Marine Rev—June 6, 1901. No. 41527.

Model Basin.

The United States Experimental Model Basin. Illustrated description of this method of determining the resistance of a ship. 1100 w. Sci Am—June 1, 1901. No. 41286.

Ocean Steamships.

Ocean Steamships Half a Century Ago. The first of a series of articles reviewing the ocean steamships built at and running from the port of New York. 3000 w. Naut Gaz—July 4, 1901. Serial. 1st part, No. 42001.

Paying Ships.

Useful or Earning Capacity of Ships. Theodore Lucas. A discussion of points to be carefully considered to insure the money earning capacity of ships. 2200 w. Naut Gaz—June 6, 1901. No. 41543.

Propellers.

Screw Propellers. McKim Chase. Suggestions for the construction of small screw propellers. Ill. 1500 w. Mach, N. Y—July, 1901. No. 41957.

Schooners.

Description of the Steam Schooners Engaged in the Pacific Coast Trade. D. S. Kimball. Illustrated description of these vessels and their engines, manner of loading, etc. 1400 w. Marine Engng—June, 1901. No. 41532 C.

Searchlights.

See Electrical Engineering, Lighting.

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Ship Building in the Nineteenth Century. Brief account of the beautiful collection of models shown at the Glasgow exhibition. 1800 w. Marine Rev—May 30, 1901. No. 41300.

The Mechanical Equipment of the Shipyard. Prof. J. H. Biles. The third paper of the series discusses the general arrangement of the plant and the economic advantages of portable electric and pneumatic tools. 3500 w. Engineering Magazine—July, 1901. No. 41774 B.

Works of the New York Ship Building Co. An illustrated description of the works, power producing appliances, and contracts under way. 10000 w. Marine Rev—June 13, 1901. No. 41597.

Shipping.

The American Shipping Purchase. Editorial discussion of the purchase of the Leyland Line of steamers by J. S. Morgan & Co., and J. P. Morgan & Co., giving the details of the transaction. 1800 w. Engng—May 3, 1901. No. 40847 A.

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The Development of Smokeless Powder in the United States. F. A. Wilcox. A consideration of the methods and means employed in the development of smokeless propulsive explosives for military purposes. 2500 w. Engng—May 31, 1901. Serial. 1st part. No. 41500 A.

Curve of Stability. George Crouse Cork. Explains the practice of Scotch shipbuilders in this problem of ship design. Ill. 2000 w. Marine Rev—June 6, 1901. No. 41526.

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Stability of Passenger Steamers After Collision at Sea, with Discussion of Means to Prevent Capsizing. M. Bertin. Read before the Paris Congress of Naval Archts. Discusses the different methods of foundering, and the means of securing

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stability. 2800 w. Marine Engng—June, 1901. No. 41530 C.

The Graphical Determination of the Stability of Ships (Graphische Ermittelung der Stabilität des Schiffes). M. H. Bauer. A study of the method of replacing cumbersome analytical methods by a simple graphical construction. Serial, Part I. 1200 w. Schiffbau—June 8, 1901. No. 41723 D.

Steamboat Race.

A Great Steamboat Race. An account of a race on Lake Erie in which the "City of Erie" beat the "Tashmoo" in a run of nearly 100 miles by only 45 seconds. 2000 w. Marine Rev—June 6, 1901. No. 41525.

Official Reports on Erie-Tashmoo Contest. Data taken on each boat is given. Illustrates the indicator cards taken. 1200 w. Marine Rev—June 13, 1901. No. 41598.

Steamers.

Elegant Excursion Steamer. Illustration with an account of the trial trip of the "Thomas Patten," built for service on New York Bay. 1300 w. Naut Gaz—July 4, 1901. No. 42000.

Side-Wheel Passenger Steamer for Lake Champlain. Brief illustrated description of the Transportation Co.'s steamboat "Vermont." 700 w. Marine Engng—July, 1901. No. 42011 C.

Steamship.

New Coasting Steamer. Illustrated description of a compact and well designed wooden propeller under construction at San Francisco. 1000 w. Naut Gaz—May 30, 1901. No. 41425.

Ocean-Going Steamship "Northwestern," Built on the Great Lakes. Illustration of the vessel and engines, with description. 1300 w. Marine Engng—June, 1901. No. 41528 C.

The Mission Stern-Wheel Steamer "Livingstone." Illustrated description of a steamer for missionary work on Stanley Pool. 600 w. Engr, Lond—May 24, 1901. No. 41365 A.

Steamship Plant.

See Electrical Engineering, Generating Stations.

Submarine.

Launch of the Submarine Torpedo Boat "Fulton." Illustrates the launch of this boat which is to be used by the Holland Company as an experimental vessel. 500 w. Sci Am—June 22, 1901. No. 41693.

Thames Service.

The Thames Steamboat Service. Arnold F. Hills. Reviews the history of the Thames Steamboat Company and the special conditions to which the service is subject; discussing also what remains to be accomplished. General discussion follows. 9000 w. Jour Soc of Arts—May 3, 1901. No. 40842 A.

Tide Indicator.

An Electrical Tide Indicator. Grahame H. Powell. Illustrated description of a device for indicating tide levels in connection with artillery range finding. 600 w. Elec Wld & Engr—May 25, 1901. No. 41284.

Ventilation.

Explanation of a Simple Method of Laying Out Ship Ventilating Cowls. George C. Stanley. Presents a group of six cowls and a simple method of determining their outlines. 1000 w. Marine Engng—June, 1901. No. 41531 C.

The Warming and Ventilation of War Ships (Verwarnung en Ventilatie van Oologsschepen). L. N. Alta. Showing arrangements of heating coils and electrically driven fans. 1500 w. De Ingenieur—April 13, 1901. No. 41767 B.

Vibration.

Pallographic Investigations on the Steamship "Deutschland" (Pallographische Untersuchungen au Bord des Schnelldampfers "Deutschland"). A full review of the tests of the Schlick system of counterbalancing as made on the "Deutschland" in June, 1900. 3 articles, 5000 w. Schiffbau—April 23, May 8, 23, 1901. No. 41721 each D.

Yachts.

"Constitution." W. P. Stephens. Illustrated description of this new Cup defender, and information related. 4500 w. Rudder—June, 1901. No. 41516 C.

Constitution and Her Early Trials. W. P. Stephens. An illustrated account with remarks on the American rules and conditions of yachting. 2000 w. Rudder—July, 1901. No. 41998 C.

Launch of "Independence." An illustrated account of the launch of this Cup defender, built at Boston. 1000 w. Rudder—June, 1901. No. 41518 C.

"Shamrock II." Illustrated description of the appearance, and the editor's opinion of her chances in the coming race. Also an account of this vessel by Goeffrey de Holden-Stone. 4900 w. Rudder—June, 1901. No. 41517 C.

The U. S. S. Mayflower. Illustrated description of a fine private yacht, purchased by the U. S. Government during the Spanish-American war. 450 w. Marine Engng—July, 1901. No. 42008 C.

Trial Trip of Independence. C. D. Mower. An illustrated account of the June 3d trial trip. 2100 w. Rudder—July, 1901. No. 41997 C.

The Racing Yacht "Independence." Illustrates and describes this racing yacht. 1100 w. Sci Am Sup—June 29, 1901. No. 41865.

The Three Cup-Yachts of 1901. Discusses the designs of the "Independence," the "Constitution," and the "Shamrock II.," giving illustrations. 1000 w. Sci Am—June 22, 1901. No. 41694.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Tables of Comparative Data of Accumulators. The data refers chiefly to the cells exhibited in Paris, or to those which took part in the Automobile Club Competition of 1899. 1200 w. Elec Chem & Met—May, 1901. No. 41485 A.

The Sperry Battery. Brief illustrated description of the battery used on the Waverley vehicles. 900 w. Horseless Age—May 29, 1901. No. 41298.

Fuel Pressure.

Fuel Pressure Air Pumps. Charles F. Schaeffer. Illustrates and describes a pump designed for keeping up the air pressure in the gasoline tank. 700 w. Horseless Age—May 29, 1901. No. 41299.

Gasoline Vehicle.

The Fastest Gasoline Automobile. Illustrates details of the Bolide gasoline racing carriage. 1100 w. Sci Am Sup—June 15, 1901. No. 41590.

Gears.

Transmission Gears of Some European Cars. Abstract from a paper by Herbert Austin before the Cycle Engr.'s Inst., London. Describes and compares the Panhard, the De Dietrich and Recault systems. Ill. 4700 w. Auto Mag—July, 1901. No. 41845 C.

Horse-Power.

The Tractive Horse-Power of Vehicles. W. F. D. Crane. Tables for the calculations and comparisons of the horse-power required are given with explanatory notes. 3300 w. Elec Wld & Engr—June 1, 1901. No. 41406.

Japan.

Automobiles in Japan. An account of the vehicles seen, the facilities for securing supplies, the roads, repairs, etc. 1800 w. Horseless Age—June 12, 1901. No. 41569.

Krieger.

Electric Automobile—Krieger System. Illustrated description of one of the latest types. 600 w. Sci Am—June 8, 1901. No. 41450.

Liverpool Trials.

The Liverpool Motor Wagon Trials. An account of these trials, with illustrations of some of the vehicles, and statement of the points taken into consideration by the judges in making the awards. 3000 w. Engr, Lond—June 7, 1901. No. 41613 A.

The Liverpool Trials of Heavy Motor Vehicles. An account of the trials in progress, the vehicles entered, and tabulated report of the rst three days. Ill. 4500 w. Engng—June 7, 1901. No. 41609 A.

Trials of Motor Vehicles for Heavy Traffic. An account of the performances of the thirteen vehicles which took part in the Liverpool trials. Ill. 5000 w. Autocar—June 8, 1901. No. 41626 A.

Lorries.

Competition for Automatic Lorry in Great Britain. Conditions for a self-propelled lorry, or wagon, for military purposes. 800 w. U S Cons Repts, No. 1067—June 20, 1901. No. 41674 D.

The Motor Lorries Which Will Compete in the Liverpool Trials. Illustrates and describes the vehicles which took part in the recent trials. All are steamers coke or oil fired, with the exception of two, which are driven by internal combustion engines, and consume motor spirit. 7400 w. Autocar—June 1, 1901. No. 41479 A.

Motor Vehicle.

A Remarkable Motor Wagon. Illustrated description of a novel wagon, invented in Germany, and tested severely with successful results. It is an attempt to secure ease of running whatever the nature of the road-surface. 1300 w. Engr, Lond—May 31, 1901. No. 41494 A.

Racing.

Motor Car Racing in France. Remarks on the importance French manufacturers attach to speed, and the improvements, with brief report of the races. 2000 w. Engr, Lond—June 7, 1901. No. 41612 A.

The Paris-Bordeaux Race. An account of the Gordon-Bennett cup competition and the open race, with illustrations. 4800 w. Autocar—June 8, 1901. No. 41625 A.

Steam Coach.

The Steam Coach in 1825. Robert I. Clagg. An illustrated account of an early vehicle taken from the *American Mechanics' Magazine* of Dec. 17, 1825. 1700 w. Ir Trd Rev—June 6 ,1901. No.41534.

Test.

Laboratory Test of a Gasoline Automobile. F. A. Lockwood. An account of a test made in the Mech. Laboratory of Sibley College. Describes the vehicle and method of testing. 1500 w. Sib Jour of Engng—June, 1901. No. 41669 C.

Tires.

Automobile Tires. Pardon W. Tillinghast. Discusses the fabric of the tire and means for securing on the wheel. 1200 w. Horseless Age—June 26, 1901. No. 41853.

The Michelin Pneumatic. Abstracts

from articles by M. Michelin, published in the *Auto-Vélo*, on the manufacture and care of pneumatic tires. Ill. 1200 w. Horseless Age—June 26, 1901. No. 41858.

The Tire Question in Light and Heavy Vehicles. Albert L. Clough. Discusses the severe conditions imposed upon tires of heavy vehicles as compared with the light vehicle, and the need of a reliable, durable and moderately expensive tire. 800 w. Horseless Age—June 26, 1901. No. 41857.

Tires. Charles E. Duryea. An account of tests to determine what tire rides easiest, propels easiest and is most durable. 1500 w. Horseless Age—June 26, 1901. No. 41852.

Wheels.

Automobile Wheels. C. C. Bramwell. Briefly states the writer's conclusions concerning the wire and the tubular wheels. 500 w. Horseless Age—June 26, 1901. No. 41854.

I. Experience of Users. Dr. H. L. Stickney. I. I. Jules Junker. Considers the merits of wheels and tires. 6500 w. Horseless Age—June 26, 1901. No. 41859.

Some New Ideas in Wheels and Tires. Harry E. Dey. An illustrated discussion of design, and the power consumed. 1800 w. Horseless Age—June 26, 1901. No. 41855.

Wood and Wire Wheels. P. M. Heldt. Discusses the construction. Ill. 2300 w. Horseless Age—June 26, 1901. No. 41856.

HYDRAULICS.

Fire Pumps.

Specifications for Fire Pumps. Abstracts of three committee reports presented at the meeting of the Nat. Fire Protective Assn. 1800 w. Eng News—June 20, 1901. No. 41813.

Flow.

The Flow of Water in Pipes. A discussion of the effect of insufficient experimental investigations of the flow of water on the formulas used in computing pipe sizes. 1500 w. Eng Rec—June 8, 1901. No. 41460.

Hydraulic Elevators.

Valve Gear for High Pressure Hydraulic Elevators. William Baxter, Jr. States where the high-pressure system is advantageous and gives an illustrated description of the general arrangement of the valves for the Otis high-pressure system. 1500 w. Am Mach—June 6, 1901. No. 41434.

Lachine Rapids.

See Electrical Engineering, Generating Stations.

Plumbing.

Plumbing in the Temple Bar Building, Brooklyn. Illustrated description of the work in a 14-story office building, having closed pressure tanks in the top story from which the building is supplied, through reducers where the pressure is too great. 1500 w. Eng Rec—May 11, 1901. No. 40873.

Siphoning.

Experiments Bearing on the Siphoning of Closet Traps. An illustrated record of the results of experiments carried out on the apparatus fitted in the Parkes Museum. 1500 w. Jour San Inst—April, 1901. No. 41276 F.

Tank Failure.

Failure of a Cast-Iron Tank. P. Hutchison. Description of the tank, the failure and the cause. Ill. 600 w. Prac Engr—May 24, 1901. No. 41348 A.

Water Motors.

Some Tests of Tangential Water Motors. R. R. Keely. Practical points regarding these motors and account of tests made at Sibley College. Ill. 1400 w. Sib Jour of Engng—June, 1901. No. 41670 C.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

The Problem of the Moulder. John G. Sadlier. The slow advancement in foundry practice is discussed and the importance of selecting the right apprentices and educating them. 1800 w. Jour Am Found Assn—June, 1901. No. 41320.

Bevel Gears.

Commercial Bevel Gears for Shafts at Any Angle. W. C. Conant. Showing that the gears listed as standard for driving shafts at right angles to each other may be used for driving shafts whose center lines intersect at any other given angle. 1200 w. Am Mach—June 13, 1901. No. 41574.

Brass.

Melting Brass. C. Vickers. Discusses some points in connection with the handling of crucibles. 1000 w. Jour Am Found Assn—June, 1901. No. 41322.

Brass Foundry.

Fitting Up a Brass Foundry. Illustrates and describes the fitting of a new brass foundry in connection with a plant making brass fittings for steam and gas. 1400 w. Am Mach—June 20, 1901. No. 41811.

Clutch.

A New Friction Clutch. Thomas Henry Smith. Illustrates and describes the Philips friction clutch. 1000 w. Eng News—June 6, 1901. No. 41456.

Cores.

Green Sand Cores. P. R. Ramp. On the advantages of the green sand cores, and directions for making them. 1500 w. Jour Am Found Assn—June, 1901. No. 41317.

Costs.

Foundry Costs. R. C. Cunningham.

Calls attention to points affecting the economy, and offers suggestions. 1800 w. Jour Am Found Assn—June, 1901. No. 41321.

Cranes.

A 45-Ton Locomotive. Jib Crane. Illustrated description of a crane recently built for the naval station at Port Royal, S. C. 600 w. Eng Rec—June 1, 1901. No. 41343.

Electric Gantry Cranes (Fahrbare Bockkrane mit Elektrischem Autrieb). W. Müller. Illustrated descriptions of two powerful gantries. The various functions in each crane are obtained by gearing driven by single electric motor. 1000 w. Zeitschr d Ver Deutscher Ing—May 18, 1901. No. 41711 D.

Dies.

Bending Dies. Jos. V. Woodworth. Illustrated description of punch and dies. 600 w. Am Mach—May 30, 1901. No. 41294.

Drills.

Twist Drill Tests. Eugene C. Peck. Description of a testing apparatus which automatically records the feed pressure and the torsional stress on a drill in operation. 1000 w. Am Mach—May 30, 1901. No. 41293.

Engraving.

Engraving Machine. Illustrated description of an instrument which will produce both lettering and designs either sunk or in relief on metals and other materials. 1400 w. Engng—May 24, 1901. No. 41367 A.

Expense.

The Proper Distribution of the Factory Expense Burden. A. Hamilton Church. The first of a series of papers dealing with this important subject, treats of the interlocking of general expense with price costs. 3500 w. Engineering Magazine—July, 1901. No. 41773 B.

Foundry.

Foundry Metallurgy. Herbert E. Field. Discusses the results that may be expected and how they are best accomplished, with questions related to the mixing of irons. 5000 w. Jour Am Found Assn—June, 1901. No. 41376.

The Foundry, Its Equipment and Management. Edwin B. Gilmour. Discusses what a modern foundry should be when quantity and quick delivery are of greatest importance. Ill. 3000 w. Jour Am Found Assn—June, 1901. No. 41325.

Gear Teeth.

Table for the Strength of Gear Teeth by Diametrical Pitch. Gives table based on the Lewis formula, with explanation. 400 w. Am Mach—June 20, 1901. No. 41810.

Key Seaters.

Keyseaters at the Glasgow Exhibition. Illustrated description of machine tools of this class; two of British manufacture and the remainder from the United States. 2300 w. Engng—May 31, 1901. No. 41501 A.

Krupp Works.

The Krupp Works. From *L'Illustration*. Illustration of the proving grounds, with information concerning these noted works. 1800 w. Sci Am Sup—June 1, 1901. No. 41288.

Machine Works.

The German Niles Machine Shop (Die Deutsche Niles-Werkzeug maschinen-Fabrik). A very full account of the new machine-tool building establishment at Ober-Schöneweide, near Berlin. 5000 w. 3 plates. Zeitschr d Ver Deutscher Ing—May 25, 1901. No. 41712 D.

The Shops of the Willans & Robinson Company, at Rugby, England. An illustrated description of some interesting things seen when the Am. Soc. of Mech. Engrs. were entertained by this firm. 3800 w. Am Mach—June 6, 1901. No. 41433.

Management.

Control of the Foundry. Percy Longmuir. On the relation of laboratory and foundry and the education needed by the manager. 1600 w. Jour Am Found Assn—June, 1901. No. 41318.

Mixing Iron.

Effects of Variations in Manganese on Different Grades of Iron. Thomas D. West. Tabulated results from a wide range of experiments, with an outline of the method of testing. Ill. 2000 w. Jour Am Found Assn—June, 1901. No. 41378.

The Relation of the Laboratory to the Foundry. Percy Longmuir. Discusses the advantages of the laboratory in connection with foundry work. 2200 w. Jour Am Found Assn—June, 1901. No. 41324.

The Value of Mixing by Analysis. Jas. A. Murphy. Suggestions for foundry work, with the writer's method of recording pig iron shipments. 1100 w. Jour Am Found Assn—June, 1901. No. 41377.

Molding.

Molding a Crosshead Guide with a Pattern Which Makes Its Own Core. R. H. Palmer. Illustrated description of the method. 1200 w. Am Mach—June 20, 1901. No. 41809.

Packing.

Some Characteristics of Waste Packing. T. H. Symington. An account of investigations, giving a more exact method of determining the value of various wastes for this purpose, with general discussion. Ill. 3200 w. W Ry Club—May, 1901. No. 41801 C.

Ordnance.

The 16-Inch Breech-Loading Rifle, Type, Model 1895. J. P. Farley. Report containing description of gun and its con-

struction, with many plates. 8500 w. Jour U S Art—May-June, 1901. Serial. 1st part. No. 41602 D.

Planing.

A Link Planing Fixture. Nicholas B. Miller. Illustrates and describes an attachment used for planing links, link blocks and quadrants. 500 w. Am Mach—June 13, 1901. No. 41577.

Ram Pressure.

Testing Ram Pressures in Presses. Oberlin Smith. Describes the system used by the writer which is nearly enough accurate for most practical purposes. 1300 w. Am Mach—June 20, 1901. No. 41808.

Shop Heating.

Heating in the Fore River Engine Company's Shops. Illustrated description of a hot-blast system of mechanical heating and ventilation in two large buildings having considerable exposure. 1500 w. Eng Rec—June 1, 1901. No. 41346.

The Heating of Workshops (Ueber Fabrikheizungen). Otto Marr. An examination of the prevailing conditions, and a discussion of the use of exhaust, mixed, and high pressure steam, as well as hot air and gas. The preference is given to exhaust steam, aided by reduced pressure steam from the boilers. Two articles, 5000 w. Gesundheits-Ingenieur —April 30, May 15, 1901. No. 41762 each B.

Shops.

A Machine Shop on Wheels. George D. Campbell. An illustrated description of a novel traveling shop. 700 w. Am Mach—May 2, 1901. No. 40707.

Tools.

Three Box Tools and Some Other Fixtures. A. H. Cleaves. Illustrated description of special box tools for turret lathe work, tools for counter-sinking rivets, a die holder and a graduating tool. 900 w. Am Mach—June 13, 1901. No. 41576.

Wastes.

Utilization of the Wastes From the Use of White Metals. Joseph Richards. The writer's experience in the utilization of tin clippings, galvanized iron scrap, and other wastes from metallurgical operations. 3600 w. Jour Fr Inst—June, 1901. Serial. 1st part. No. 41617 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Obtaining the Approximate Weight of Alloys Before Making. Walter J. May. An explanation of a simple method. 1500 w. Prac Engr—June 14, 1901. No. 41824 A.

Cast Iron.

Influence of Titanium on the Properties of Cast Iron. Auguste G. Rossi. The writer's experience in using ores containing titanium, with report of tests made to show the effect of adding various quantities of ferro-titanium to ordinary foundry mixtures. 3600 w. Jour Am Found Assn—June, 1901. No. 41319.

Report of the Committee on Standardizing the Testing of Cast Iron. Ill. 3000 w. Jour Am Found Assn—June, 1901. No. 41379.

Drop Tests.

Experiments in Flexure by Drop Tests. (Quelques Expériences de Flexion par Choc.) J. Barba. Data and results of the method of drop test upon nickel test bars; the experiments being conducted in the shops of the Eastern Railway of France. 3500 w. Mem Soc Ing Civ de France—April, 1901. No. 41727 G.

Flow.

The Flow of Metal. Henrik V. Loss. An account of recent experiments supporting the writer's statement that the accepted power to punch steel is decidedly an unnecessarily large one. Discussion. 1500 w. Jour Fr Inst—June, 1901. No. 41618 D.

India Rubber.

India-Rubber and Its Sources of Supply. Briefly reviews the past supply and what is being done to ensure the supply for the future. 3000 w. Engr, Lond—May 31, 1901. No. 41496 A.

Matter.

Extension of the Group Theory of Atoms and Molecules. Arthur A. Skeels. Results and conclusions of several years' study of the laws governing the properties and phenomena of matter. 6200 w. Jour Assn of Engng Socs—March, 1901. No. 40991 C.

Metal Expansion.

On the Expansion of Certain Metals at High Temperatures. Ludwig Holborn. An account of investigations by a new method, with tabulated report of observations. 5000 w. Am Jour of Science—May, 1901. No. 40618 D.

Resistance.

The Study of the Resistance of Materials (Zur Festigkeitslehre). O. Mohr. A general review of the physical problems involved in the study of the resistance of materials. 3000 w. Zeitschr d Ver Deutscher Ing—May 25, 1901. No. 41714 D.

Steel Castings.

The Properties of Steel Castings. John Oliver Arnold. Read before the Iron & Steel Inst. An illustrated account of researches commenced about six years ago in the steel works and laboratories of the Sheffield (Eng.) Univ. College. 4200 w. Engng—June 7, 1901. Serial. 1st part. No. 41611 A.

Testing.

Tension Tests with Nicked Test Bars (Zugversuche mit Eingekerbten Probe körpern). A. Martens. Data and results of trials with the system of Prof. Barba, as applied at the Charlottenburg laboratory. 5000 w. Zeitschr d Ver Deutscher Ing—June 8, 1901. No. 41717 D.

POWER AND TRANSMISSION.

Bearings.

Anti-Friction Bearings. Illustrated examples of devices for reducing frictional resistances. 4200 w. Mach, N. Y.—June, 1901. No. 41411.

Chains.

Chain and Chain Gearing. Charles Piez. Illustrated discussion of the principle of chain gearing, the care needed, etc. 2200 w. Am Mfr—May 30, 1901. No. 41296.

Crank.

The Velocity Relations of a Cranked Quadrangle (Ueber den Beschleunigungs zustand eines Kurbelvierecks). Dr. A. Herzog. A geometrical analysis of velocity ratios in a four-sided linkage, using the method of instantaneous centers. 1200 w. Schweizerische Bauzeitung—May 11, 1901. No. 41755 B.

The Dynamics of Crank Driving (Dynamik der Kurbelgetriebe). Dr. H. Lorenz. An analytical study of the relations of the tangential and rotative forces in driving a crank by a connecting rod. 25000 w. Schiffbau—June 8, 1901. No. 41722 D.

SPECIAL MOTORS.

Gas Engines.

Types of Gas Engines in Most Common Use. Fritz W. Lurmann. Condensed translation from *Stahl und Eisen.* States the fundamental principles upon which gas motors are constructed, and points out their differences. Ill. 1200 w. Ir & Coal Trds Rev—June 7, 1901. No. 41607 A.

Gasoline Engines.

Cylinder, Piston and Packing Rings. L. Berger. Considers French and American practice, and gives information relating to the packing. 1500 w. Horseless Age—June 5, 1901. No. 41430.

STEAM ENGINEERING.

Boilers.

A Boiler-Shell Chart. Lawford H. Fry. Chart, with explanation and illustration of its use. 800 w. Am Engr & R R Jour—June, 1901. No. 41442 C.

Calculating the Strength of Steam Boilers. W. H. Wakeman. Some points concerning tensile strength, joints, and bursting pressure. 1000 w. Elec, N. Y.—June 12, 1901. No. 41572.

Steam Boiler Economy. William Kent. Abstract of a lecture delivered before Sibley College. Discusses the design of the plant and points affecting the economy. 1500 w. Sib Jour of Engng—June, 1901. No. 41668 C.

The Cahall Water-Tube Boiler. States the 12 requirements that George H. Babcock considered necessary for a perfect steam boiler, and gives an illustrated description of this boiler which claims to fulfill them. 2200 w. Ir & Coal Trds Rev—June 14, 1901. No. 41844 A.

The Dürr Water-Tube Boiler. Illustrated description and general information of this boiler. H. M. S. "Medusa" is to be fitted with eight boilers of this type. 2200 w. Engr, Lond—May 31, 1901. Serial. 1st part. No. 41492 A.

The Transmission of Heat Through Scale-Covered Boiler Tubes. Edward C. Schmidt. Gives tabulated results of tests made at the Univ. of Illinois, for the purpose of measuring the number of heat units transmitted per hour through the different tubes; describes methods used. 1000 w. R R Gaz—June 14, 1901. No. 41651.

The Work Done in a Boiler. Editorial discussing the boiler as an efficient converter of heat into work. 2400 w. Engr, Lond—May 24, 1901. No. 41364 A.

Water-Tube Boilers in the Navy. A letter from Marquis de Chasseloup Laubat, discussing the "interim report" of the Water-Tube Boiler Committee. 3800 w. Engng—May 24, 1901. No. 41368 A.

Boiler Test.

Evaporation Test of Dürr Boilers (Verdampfungs-Versuch an Dürr kesseln). Data and results of Dürr boilers fired with producer gas and provided with superheaters. 1000 w. Glückauf—May 18, 1901. No. 41730 B.

Brooklyn Navy Yard.

The Steam Engineering Power Station at the Brooklyn Navy Yard. Illustrated description of the electric generating station built to furnish power to the extensive engineering shops at the Brooklyn Navy Yard. 2800 w. Eng Rec—June 1, 1901. No. 41339.

Engine Balancing.

The Geometry of Engine Balancing. J. Macfarlane Gray. Read before the Inst. of Nav. Archts. Considers the drawing-office methods of applying the principles of engine balancing. Ill. 4600 w. Engng—May 31, 1901. No. 41504 A.

Engine Tests.

Test of the Corliss Engine at the Saratoga Mine, Central City—Some Pumping Data. Thomas L. Wilkinson. Abstracts of a paper read before the Colorado Scientific Society. Remarks on the importance of engine testing, with report of the test named. 1500 w. Min Rept—June 20, 1901. Serial. 1st part. No. 41846.

Forced Draft Test.

Some Results of a Test of Heating and

Ventilating Apparatus. O. B. Zimmerman. A statement of the conditions and a test where 96 observers were used after having special drill, and the results. 2300 w. Wis Engr—May, 1901. No. 41386 D.

Grates.

The Kudlicz Grate. L. Brousse, in *L'Ingénieur Français.* Illustrates and describes a grate intended to solve the problem of continuous mechanical feed, stoking or clearing the firebars, and removing the products of combustion. 1000 w. Col Guard—May 31, 1901. No. 41505 A.

Marine Engines.

The Steamships "Port Royal" and "Port Antonio." Illustrated description of the triple-expansion engines of two steamships constructed to be worked under a government subsidy for the development of U. S. trade with the West Indies. 1500 w. Sci Am Sup—June 29, 1901. No. 41866.

Oil Filters.

Filters for Removing Oil and Mud from Boiler Feed-Water. Illustrated description of a filter used both in land and marine boiler plants. 700 w. Eng News—June 13, 1901. No. 41583.

Paper Making.

Steam Engineering in Paper and Pulp Mills. W. D. Ennis. A study of steam economy in an important steam-using industry. Engineering Magazine—July, 1901. No. 41776 B.

Piping.

Standard Pipe Dimensions for High-Pressure Steam (Normalien zu Rohrleitungen für Dampf von Hoher Spannung). A discussion of the standard pipe and flange dimensions adopted by the *Verein Deutscher Ingenieure.* 3500 w. 1 plate. Gesundheits-Ingenieur—April 15, 1901. No. 41759 B.

Pistons.

Extension Piston Rods and Wear of Locomotive Cylinders. J. L. Doherty. Statements, with illustrations, bearing upon this subject, and the writer's opinion. 1800 w. R R Gaz—June 14, 1901. No. 41649.

Powdered Fuel.

Powdered Fuel for Boiler Furnaces at the Alpha Cement Co.'s Works, Alpha, N. J. Illustrates and describes the apparatus and its operation for preparing the powdered fuel. 1400 w. Eng News—June 20, 1901. No. 41815.

Power Plant.

The Mechanical Plant of a Baltimore Office Building. Illustrated description of the steam, elevator, lighting, telephone, heating and ventilating plant in the building of the Maryland Telephone and Telegraph Co. 3800 w. Eng Rec—May 4, 1901. No. 40727.

Some Mechanical Details in High Office Buildings. Notes on the elevator equipment, chimneys, and other plant, given in a paper by R. P. Bolton before the Inst. C. E. 800 w. Eng Rec—June 1, 1901. No. 41344.

Prime Movers.

Determination of the Angular Displacement of Prime Movers. Lionel Fleischmann. Mathematical demonstration showing that the angular displacement is not only dependent upon the maximum change in speed, but also determined by the general character of the velocity curve. 800 w. Elec Wld & Engr—June 1, 1901. No. 41404.

Quadruple Expansion.

Quadruple Expansion Steam Engine (Machine à Vapeur à Quadruple Expansion). G. Eude. A description of the Bourdon trunk quadruple expansion engine, exhibited at Paris. 1800 w. Génie Civil—June 8, 1901. No. 41707 D.

Smoke.

The Smoke of Paris (Les Fumées de Paris). An examination of the pollution of the air of Paris by smoke and a discussion of the measures taken for smoke prevention. 1800 w. Génie Civil—May 25, 1901. No. 41705 D.

Steam Engines.

Eight Thousand Horse Power Engines for the Manhattan Power Station. Illustrated detailed description of these powerful steam-operated machines. 1700 w. Power—June, 1901. No. 41426.

Steam Engines at the Glasgow Exhibition. The present article describes Robey & Co.'s horizontal cross-compound engine. Ill. 2200 w. Engr, Lond—May 31, 1901. Serial. 1st part. No. 41493 A.

Steam Engine for Walker-on-Tyne Electric Station. Illustrated description of a 1400 indicated horse-power set of triple-expansion engines, specially interesting in view of the great economy attained in steam consumption. 700 w. Engng—June 14, 1901. No. 41836 A.

Steam Turbine.

A Test of a Steam Turbine. F. E. Cardullo. Reports a test on the Parsons steam turbine at Sibley College. Ill. 2000 w. Sib Jour of Engng—June, 1901. No. 41667 C.

Trial of a Turbo-Generator After Twelve Months Working. An interesting report by Prof. Ewing, giving particulars of a test of Parsons turbo-generator. 1400 w. Engng—June 14, 1901. No. 41837 A.

The Parsons Steam Turbine (Turbine à Vapeur Parsons). M. Duchanoy. A review of the progress of the steam turbine, describing exhibit at Paris, and details of recent tests. 2000 w. Génie Civil—May 18, 1901. No. 41700 D.

Valve Motion.

Link Motion and Piston Valves. C. A.

Seley. Discusses the extensive use of piston valves, their location, various styles and their advantages. 1800 w. Am Engr & R R Jour—June, 1901. No. 41441 C.

MISCELLANY.

Absolute Temperature.

Concerning Absolute Temperature. Explains the term as used in the temperature scale of the perfect gas thermometer, showing the line of reasoning by which the existence of the absolute zero is established. 3500 w. Locomotive—April, 1901. No. 41064.

Address.

Mattoids in Engineering. H. F. J. Porter. Extracts from a paper presented to the Am. Water Wks. Assn. Remarks on the growing tendency to assume the truth of certain statements of facts without investigation, and whose misconceptions lead often to danger. Several examples are given in illustration. 2800 w. Eng Rec—June 22, 1901. No. 41874.

Air Compressors.

Double Compound Compressor (Zwillings-Verbund Kompressor). Illustrated description and account of tests of air compressor at the Emscher pit of the Cologne Mining Company. Indicator diagrams from steam and air cylinders are given. 1200 w. 2 plates. Glückauf—May 25, 1901. No. 41732 B.

Inlet Valves and Their Relation to the Efficiency and Volumetric Capacity of Air Compressors. Fred. Brainard Corey. Calls attention to some of the peculiarities of inlet valves of the usual types with the object of aiding the designer and user in making an intelligent choice. 2300 w. Eng News—May 30, 1901. No. 41304.

Some German Air-Compressors. Illustrations and particulars relating to the Humboldt compressor, and also the Dingler compressor. 1800 w. Quarry—June 1, 1901. No. 41593 A.

Air Currents.

Changes in Velocity and Direction of Air Currents (Changements der Direction et de Vitesse d'un Courant d'Air). M. Marey. An examination of the influence of resisting bodies of various forms in the path of air currents. 1800 w. Comptes Rendus—June 3, 1901. No. 41739 D.

Artillery.

Boer Field Artillery. An illustrated discussion of some of the field guns used by the Boers, purchased from the best French, German and Austrian gun-making firms. 3500 w. Engr, Lond—April 26, 1901. No. 40810 A.

The Development of the Mode of Ignition in Small Arms and Artillery. A review of the progress of invention in this field, with illustrations. 2700 w. Engr, Lond—May 10, 1901. Serial. 1st part. No. 41037 A.

Chronometers.

A Practical Method of Correcting the Secondary Error of Chronometers (Procédé Pratique pour la Correction de Erreur Secondaire des Chronometres). C. E. Guillaume. Showing that the very slight expansibility of certain nickel-steel alloys makes it suitable for balance springs for chronometers. 1000 w. Comptes Rendus—May 6, 1901. No. 41736 D.

Flow.

The Flow of Semi-Fluids Through Orifices. Willis Whited. The experiments described were performed with wheat. Also discussion. Ill. 3400 w. Pro Engs Soc of W Penn—April, 1900. No. 41-603 D.

Heating Plant.

Heating in the Marion County Court House, Fairmont, W. Va. Illustrated description of a plant for warming a building by means of a fan forcing heated air through underground ducts to the various flues leading to the rooms. 1800 w. Eng Rec—May 25, 1901. No. 41218.

Heating the Reptile House at Bronx Park, New York. Illustrated description of a low-pressure hot-water apparatus designed to maintain a temperature of 80° in zero weather. 1400 w. Eng Rec—June 22, 1901. No. 41875.

Name Plates.

Name Plates. Edmund S. Sperry, in the *Aluminum World*. Describes methods of making and attaching such plates. 1400 w. Foundry—June, 1901. No. 41281.

Pistol.

The Luger Automatic Pistol. Grahame H. Powell. An illustrated description of the weapon and its operation. 1000 w. Am Mach—May 16, 1901. No. 40939.

Refrigeration.

A "Boer" Cold Storage Plant in South Africa. Illustrates and describes the plant at Durban, S. Africa. 4800 w. Ice & Refrig—June, 1901. No. 41407 C.

Cold Air Refrigeration. H. Muenster. Describes an example of abattoir refrigeration on the cold air system in Germany. 2000 w. Ice & Refrig—June, 1901. No. 41409 C.

Cold Storage at Nome, Alaska. Brief illustrated description of a plant at Nome City. 1000 w. Ice & Refrig—June, 1901. No. 41408 C.

The Plant of the Norfolk Refrigerating Storage Company. Illustrated description of a refrigerating and ice-making plant with an underground conduit for the public supply of refrigerating brine. 2200 w. Eng Rec—June 8, 1901. No. 41468.

Slide-Rule.

The Use of Calculating Machines. Charles A. Holden. Urging the use of the slide rule to a greater extent. 900 w. Eng News—May 30, 1901. No. 41309.

MINING AND METALLURGY

COAL AND COKE.

Coal Handling.

See Electrical Engineering, Power Applications.

Coal Problem.

The Coal Problem: Its Relations to the Empire. Carlyon W. Bellairs. A survey of the existing position of England, with conclusions. Appendix and discussion. 7000 w. Jour Soc of Arts—June 7, 1901. No. 41599 A.

Coke Plant.

See Electrical Engineering, Power Applications.

Colliery Management.

The Management and Control of the Colliery. Wm. Blakemore. Mr. Blakemore's first paper is devoted to the discussion of standard practice in opening up the mine and conducting the underground workings. 3000 w. Engineering Magazine—July, 1901. No. 41777 B.

Explosion.

Colliery Explosion in South Wales. An account of a terrible explosion involving the death of 82 miners, occurring on the 24th of May at the Universal Colliery. 2800 w. Col Guard—May 31, 1901. No. 41507 A.

The Gas Explosion in the Frischglück Mine at Dux (Die Brandgas explosion auf der Frischgluchzeche bei Dux). F. Okorn. A description of the disastrous gas explosion which occurred at Dux, in Bohemia, September 19, 1900, with an examination of the causes. Serial. Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—June 1, 1901. No. 41735 B.

The Port Royal Mine Explosion. An account of the explosions on June 10th, with editorial on the prevention of mine accidents. 1800 w. Eng & Min Jour—June 22, 1901. No. 41802.

Faunal Studies.

Coal Measures Faunal Studies. J. W. Beede and Austin F. Rogers. The first of a series of papers giving lists of the faunas of the different horizons of the Coal Measures of Kansas and certain parts of western Missouri. 5000 w. Kansas Univ Qr—Oct., 1900. Serial. 1st part. No. 41851 D.

Pennsylvania.

The Latrobe Coal and Coking Field in Pennsylvania. William G. Irwin. Brief account of this district and its recent development. 1000 w. Eng & Min Jour—June 8, 1901. No. 41510.

Pioneer Work.

Pioneer Work in the Crows Nest Coal Areas. William Blakemore. An account of the opening of this mine in the Rocky Mts., the difficulties, etc., describing the appliances, plant and machinery installed. Maps. 5800 w. Can Min Rev—May 31, 1901. No. 41420 B.

Queen Charlotte Is.

The Coal and Asphaltum Deposits of the Queen Charlotte Islands. W. F. Best. Information concerning these deposits and the exploration work on the islands off British Columbia. 1300 w. B. C. Min Rec—June, 1901. No. 41515 C.

Siberia.

Coal in East Siberia. Concerning the sources of supply for this region. 1200 w. U. S. Cons Repts, No. 1069—June 22, 1901. No. 41686 D.

Spain.

Rivals to British Coalfields. The present article considers the coalfields of Castile, in Spain, which have recently come into prominence. 1800 w. Ir & Coal Trds Rev—May 31, 1901. Serial. 1st part. No. 41509 A.

Statistics.

The Value of Coal and the Average Wages of Coal Miners. Tabulated statistics showing output, wages, value at pit's mouth, etc., based on the British Home Office statistics. 800 w. Col Guard—May 24, 1901. No. 41371 A.

Trans-Mississippi Coals.

Horizons of Arkansas and Indian Territory Coals Compared with those of Other Trans-Mississippian Coals. Charles R. Keyes. A geological study of these beds. Ill. 2000 w. Eng & Min Jour—June 1, 1901. No. 41327.

COPPER.

American Copper.

Copper Mining in America. Waldon Fawcett. A review of the rapid development of this industry, the improvement in methods and facilities for mining, etc. Ill. 1600 w. Sci Am—June 8, 1901. No. 41449.

Deposits.

The Deposits of Copper-Ores at Ducktown, Tenn. J. F. Kemp. Introductory description of deposits of this type, with topography, geology and petrography of this region, and related information. Ill. 5500 w. Trans Am Inst of Min Engrs—June, 1901. No. 41676 D.

Montana.

The Copper Mines of Butte, Montana, the World's Greatest Mining Camp. Walter Harvey Weed. An illustrated account of the deposits, the geology, mining practice, etc., with information relating to the

output, value, etc. 3400 w. Min & Met—June 1, 1901. No. 41541.

New Zealand.

Native Copper in New Zealand. W. H. Baker. Abstract of a paper in London *Mining Journal*. An account of the first lode of copper ore worked, with description of the deposits. 900 w. Eng & Min Jour—June 15, 1901. No. 41568.

GOLD AND SILVER.

Alaska.

The Golovin Bay Region of Northwestern Alaska. J. D. Lowny. Describes the characteristics of the region, its advantages over Nome, and recently organized enterprises. Gold dust assays from $17 to $19 per ounce. 1300 w. Eng & Min Jour—June 15, 1901. No. 41567.

Arizona.

The Mammoth Gold Mine, Arizona. William P. Blake. Abstract of a lecture before the students of the School of Mines, Tucson. Upon methods of working large ore deposits without costly timbering, suggested by the caving in of a large portion of this mine. 1800 w. Min Rept—June 6, 1901. No. 41513.

Assaying.

The Determination of Lead in Ores by Fire Assay. W. Lay. Concerning the sources of error in the fire assay. 1700 w. Can Min Rev—May 31, 1901. No. 41419 B.

Concentration.

Low Grade Gold Mining and Milling. Describes the practice of a leading mill in the San Juan region of Colorado, and how it is possible for low-grade ores to yield a profit. Ill. 1700 w. Sci Am Sup—June 15, 1901. No. 41591.

The Elmore Process for Concentrating Minerals (Procédé Elmore pour la Concentration des Minerais). J. Dupont. A description of the Elmore process for using oil for the concentration of gold, silver and copper. 1000 w. Génie Civil—May 18, 1901. No. 41703 D.

Cyaniding.

Cyaniding Complex Gold Ores. Frank H. Probert. Notes of interest concerning the bromo-cyanide process. 1000 w. Min & Sci Pr—June 15, 1901. No. 41689.

Gold-Dredging.

Gold-Dredging in California. E. H. Benjamin. Information concerning this industry. At present there are about twenty dredges running, which are producing about $1,000,000 per year. 3000 w. N Z Mines Rec—April 16, 1901. No. 41521 B.

Gold Dredging in the Nome District. G. P. Grimsby. An illustrated description of dredges used at Nome and why they were not successful; also an illustrated description of one being constructed for the work. 1000 w. Eng & Min Jour—June 22, 1901. No. 41807.

The Gold-Dredging Industry in Otago. Table showing capital, gold obtained, and dividends declared, with remarks on this industry. 2000 w. N Z Mines Rec—April 16, 1901. No. 41519 B.

Gold Extraction.

The Union Gold Extraction Company's Mill at Florence, Colorado. John E. Rothwell. Illustrated detailed description of this plant. 4000 w. Eng & Min Jour—June 8, 1901. No. 41511.

Gold-Veins.

The Formation of Bonanzas in the Upper Portions of Gold-Veins. T. A. Rickard. Discusses the results produced by descending surface waters, and other agencies affecting ore deposition. Ill. 7800 w. Trans Am Inst of Min Engrs—June, 1901. No. 41677 D.

Newbury, Mass.

The Lead and Silver Mines of Newbury. Horace C. Hovey. Account of a vein recently opened by quarrymen while blasting rock for the State highway. 700 w. Sci Am Sup—June 15, 1901. No. 41592.

Ore Treatment.

Concentrations of Argentiferous Galena as Carried on at Helena Frisco Consolidated Company's Mills, Gem, Idaho, U. S. A. W. Muir Edwards. Describes the ore treatment at a mine in the Coeur d'Alene district which is celebrated for its lead and silver mining. 5000 w. Can Min Rev—May 31, 1901. No. 41418 B.

Precipitation.

Electrolytic Precipitation From Potassium Cyanide Solutions. J. H. Jory. Describes construction and practice by which the author believes the Siemens-Halske process can be improved. 1200 w. Min & Sci Pr—June 22, 1901. No. 41861.

Production.

Gold and Silver Production of the United States. Tabulated report of gold and silver for the year 1897 to 1900 inclusive, with remarks. 800 w. Eng & Min Jour—June 22, 1901. No. 41803.

Gold and Silver Production of the World. Tabulated estimate for the years 1898 to 1900 inclusive, with remarks. 1800 w. Eng & Min Jour—June 22, 1901. No. 41804.

Silver.

Standard Silver: Its History, Properties and Uses. Ernest A. Smith. 1200 w. Sci Am Sup—June 8, 1901. Serial. 1st part. No. 41452.

Smelting.

Pyritic Smelting in the Black Hills. Continued discussion of Prof. Carpenter's paper, presented at the Canadian meeting. 1700 w. Trans Am Inst of Min Engrs—June, 1901. No. 41681 D.

The New Silver-Lead Ore Schedule of the American Smelting and Refining Company. Editorial discussion of the new schedule of payment. 2100 w. Eng & Min Jour—May 11, 1901. No. 40893.

Stamp Mills.

Stamp Mill Practice at Guanagnato. From the *University of Arizona Monthly.* Description. 1400 w. Min Rept—June 13, 1901. No. 41655.

Sulphides.

The Sulphide Problem. Describes the leading features of the Clancy-Marsland process, with report by the recent government geologist of New South Wales. 3700 w. Aust Min Stand—May 2, 1901. No. 41522 B.

Vancouver.

Black Sand Auriferous Deposits of Wreck Bay, Jordan River, and Other Localities of Vancouver Island. R. Lind Watson. Descriptive. Map. 1200 w. Mines & Min—June, 1901. No. 41473 C.

The Mines of Vancouver Island. Illustrates and describes mines of the Mount Sicker district, carrying iron, copper, gold and other metals. 3000 w. B C Min Rec—June, 1901. No. 41514 C.

Veins.

Mineral Vein Formation at Boulder Hot Springs. Walter Harvey Wood. An explanation of the writer's theory as to the genesis of the silver-gold veins of Lump Gulch and other mining districts in Montana. Ill. 2500 w. W. Min Wld—May 25, 1901. No. 41290.

The Role of the Igneous Rocks in the Formation of Veins. J. F. Kemp. Shows the competence of the igneous rocks to supply both the contents of veins and the solutions which are the common carriers of the minerals, and considers the phenomena and the current conceptions of the ground water. 12000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41685 D.

Witwatersrand.

The Gold Fields and Gold Industry of the Witwatersrand (Beschonwingen over de Goudvelden en Goudindustrie van den Witwatersrand). R. de Kat. A general review of the mines and the cyanide plants, with especial reference to the Rose Deep Mine. 3500 w. De Ingenieur—April 27, 1901. No. 41768 B.

IRON AND STEEL.

Cape Breton.

The Manufacture of Iron and Steel in Cape Breton. P. T. McGrath. An account of important newly developed industries which may play an important part in rising international competition. 4000 w. Engineering Magazine—July, 1901. No. 41778 B.

Heat Treatment.

The Heat Treatment of Steel. A review of information on this subject given in recently published papers, especially the investigations of Mr. Albert Sauveur. Ill. 2000 w. R R Gaz—May 31, 1901. No. 41311.

India.

The Iron and Steel Industries of India. C. Ritter von Schwarz. Extract from a series of articles in *Stahl und Eisen.* Reviews the enterprises to establish these industries and utilize the seams of coal and iron ore, and the causes of the failures. 2200 w. Ir & Coal Trds Rev—May 31, 1901. No. 41508 A.

Ingot Stripper.

See Electrical Engineering, Power Applications.

Iron Mine.

The Arragon Mine at Norway, Michigan. E. S. Dickenson. A description of the mine, the machinery used and manner of working. Ill. 2400 w. Mines & Min—June, 1901. No. 41475 C.

Iron Ore.

The First Discovery and Use of Iron Ore in North America. Historical account. 1000 w. Eng News—June 13, 1901. No. 41578.

Iron Sand.

Magnetic Iron Sand of the St. Lawrence Shore. J. Obalski. Read before the Canadian Min. Inst. Concerning the deposits and the processes suggested for agglomerating the magnetic sand. 2500 w. Can Engr—June, 1901. No. 41571.

Ore-Concentration.

Investigations of Magnetic Fields, with Reference to Ore-Concentration. Walter R. Crane. A thesis presented for the degree of Ph. D. at Columbia Univ., N. Y. Describes apparatus and methods of testing, giving the relative magnetic permeability of various iron ores. Ill. 10000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41675 D.

Slags.

The Use of the Tri-Axial Diagram in the Calculation of Slags. Ernest A. Hersam. Presents a method of graphic calculation obtained by extending the work of representation. The example selected deals with the calculation of a blast-furnace slag. 7000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41684 D.

Spanish Ore.

The Spanish Iron Ore Industry. Information concerning this industry in the province of Biscay, the geological formation, system of mining, treatment of the ore, transport, price, etc. 2000 w. Col Guard—May 24, 1901. No. 41373 A.

Steel Anaylsis.

Critical Remarks on McKenna's Method of Analysis of Tungsten and Chrome Steels. The Determination of Tungstic Acid and Separation from Silica. Translation of criticism of Otto Herting, with

reply from the author. 1800 w. Pro Engs Soc of W. Penn—April, 1901. No. 41-604 D.

MINING.

Deposits.

The Caliche of Southern Arizona: An Example of Deposition by the Vadose Circulation. William P. Blake. Describes the caliche, a deposit of carbonate of lime, and explains its origin. 2200 w. Trans Am Inst of Min Engrs—June, 1901. No. 41679 D.

The Character and Genesis of Certain Contact-Deposits. Waldemar Lindgren. Describes the character of these deposits and discusses their origin. Also discussion by S. F. Emmons. 6500 w. Trans Am Inst of Min Engrs—June, 1901. No. 41-682 D.

Diamond Drill.

The Fromholt Electric Drill. From the *Bulletin de la Société d'Encouragement pour L'Industrie Nationale.* Illustrated description of an electrically driven diamond rock drill possessing new and promising features. 1500 w. Col Guard—June 14, 1901. No. 41838 A.

Discipline.

Mine Discipline. D. C. Thomas. Read before the Ohio Min. Engrs. Discusses what constitutes discipline and the importance of system as an aid to its enforcement. 1900 w. Mines & Min—June, 1901. No. 41472 C.

Explosives.

The Causes of Misfire. A. W. Warwick and J. H. Henley. Gives an account of investigations made, with the conclusion that the fault lies in the fuse, and explains some causes. Ill. 1200 w. Min Rept—June 20, 1901. No. 41847.

Fans.

Manometrical Efficiency. J. T. Beard. Explains the meaning of the term which applies to the efficiency of a given circulation and does not express the efficiency of a fan. 1500 w. Mines & Min—June, 1901. No. 41478 C.

Hauling.

Problems in Hauling and Hoisting. Alexander Bowie. Mathematical discussion of problems useful to mining engineers. 600 w. Trans Am Inst of Min Engrs—June, 1901. No. 41678 D.

Hoisting.

Some Recent Designs for Steel Coal-Hoisting Towers. H. G. Tyrrell. Illustrated description of recent designs. 500 w. Eng News—May 30, 1901. No. 41302.

Mine Pumping.

Leadville Pumping Practice. A. W. Warwick. An account of the large volume of water to be handled and the expense and methods. Ill. 2200 w. Min & Sci Pr—June 15, 1901. No. 41688.

Mining Machinery.

Machinery in Ruhr Coal District at the Beginning of the 20th Century (Das Maschinenwesen im Ruhrkohlenbergbau zu Beginn des 20 Jahrhunderts). Dr. H. Hoffmann. Discussing the present employment of electric hydraulic, and pneumatic machinery in the Prussian coal mines. 5000 w. Zeitschr d Ver Deutscher Ing—June 1, 1901. No. 41715 D.

Ottawa, Canada.

Gas and Oil Discoveries Near Ottawa. Description of the investigations, with brief history of the borings, etc. 800 w. Cons Repts, No. 1071—June 25, 1901. No. 41823 D.

Philippines.

Mining Among the Moros in the Philippines. An account of the mining in this portion of the islands, the metals found, transportation, etc. 1900 w. Eng & Min Jour—June 1, 1901. No. 41328.

Pumping Plant.

An Electric Underground Pumping Plant of 800 Horse-Power. States the advantages claimed for electric working of underground pumps, and gives illustrated description of the plant. 1200 w. Ir & Coal Trds Rev—June 14, 1901. No. 41842 A.

Quarrying.

The Helicoidal Wire and Penetrating Pulley for Quarrying Operations. Illustrated description of the penetrating pulley and its operation, giving a statement of the advantages claimed. 1700 w. Stone—May, 1901. No. 41699 C.

Rescue Apparatus.

Rescue Apparatus—An Analogy Between Military and Mining Methods. Reviews experiments made in the mining operations of military engineers, dating back to the latter part of the 18th century. 3300 w. Ir & Coal Trds Rev—May 24, 1901. Serial. 1st part. No. 41860 A.

Rock Drills.

See Electrical Engineering, Power Applications.

Roll Crushing.

Elements in the Design of Roll Crushing Plants. Jesse Scobey. Considers improvements made in rolls since they have been used for fine crushing, and results obtained. 2500 w. Min & Sci Pr—June 1, 1901. No. 41428.

Safety Lamps.

Failures of Safety Lamps Whilst in Use. James Ashworth. On account of some of the disasters and the lessons which may be derived from them. 6600 w. Mines & Min—June, 1901. No. 41474 C.

Influence of the Form of Gauze Mantle Upon the Security of Safety Lamps (Ueber den Ein fluse der Drahtkorbform auf die Durschlagssicherheit der Wetterlamps). H. Fähndrich. A discussion of the best

dimensions for the gauze cylinder for safety lamps to prevent the ignition of gases without. 1000 w. Glückauf—May 18, 1901. No. 41729 B.

Shaft Borings.

Some Recent Shaft Borings in the Ruhr District. L. Hoffman. Translated and condensed from *Glückauf*. Information concerning a shaft of the Scharnhorst Colliery, and one at the Preussen II. Colliery. Ill. 2200 w. Ir & Coal Trds Rev—May 24, 1901. No. 41361 A.

Surveying.

Method of Connecting Survey in a Shaft Mine with That of Property Lines and Topographical Features on the Surface. H. L. Auchmuty. Explanatory. 3300 w. Mines & Min—June, 1901. No. 41471 C.

Timbering.

Some Defects in Timbering Underground. An illustrated article dealing with errors in propping. 1800 w. Ir & Coal Trds Rev—May 24, 1901. No. 41359 A.

Tunnels.

Kelly and Newhouse Tunnels. Arthur Lakes. Discusses the sources from which such tunnels derive revenue; how they are planned and the methods used in driving them. Ill. 2100 w. Mines & Min—June, 1901. No. 41477 C.

MISCELLANY.

Bromine.

A Proposed Method for the Extraction of Bromine. Anson G. Betts. On the distribution of bromine, and a proposed method based on its well-known reaction in aqueous solution with phenol. 1000 w. Eng & Min Jour—June 22, 1901. No. 41806.

Elevator.

An Elevator for Smelting Plants. Joel G. Clemmer. Drawings and description of a very well designed and convenient form of elevator for smelting and other plants. 800 w. Eng & Min Jour—June 22, 1901. No. 41805.

Fertilizer.

The Bat Guano Caves of Texas. William B. Phillips. Illustrated description of these enormous caverns containing valuable deposits of fertilizer, some of which are being worked. 3000 w. Mines & Min—May, 1901. No. 40692 C.

Gypsum.

The Gypsum and Cement Plaster Industry in California. G. P. Grimsby. Reviews briefly the different gypsum industries in California. 800 w. Eng & Min Jour—June 8, 1901. No. 41512.

Japan.

Japan and Its Mining Industries. H. L. Geissel. Information concerning the products and the recent development. 1600 w. Min & Met—June 1, 1901. No. 41540.

Mineral Wax.

Ozocerite, or Mineral Wax, in Austria. An account of these deposits, their mining, cleaning, uses, etc. 1500 w. U S Cons Repts, No. 1059—June 11, 1901. No. 41448 D.

Oil.

Prospecting for Oil in Colorado. Arthur Lakes. Considers the signs that may indicate oil, and the geological formations which are favorable. 2200 w. Ill. Mines & Min—June, 1901. No. 41470 C.

The Great Oil-Well Near Beaumont, Tex. Anthony F. Lucas. The history of the well, its control, the oil rock, and oil. Ill. 4000 w. Trans Am Inst of Min Engrs—June, 1901. No. 41683 D.

The New Oil Fields of the United States. David T. Day. Discusses the recent developments in the petroleum industry, especially the California fields and Beaumont, Tex. 2700 w. Am Rev of Revs—June, 1901. No. 41336 C.

The Present Status of the Beaumont Oil Field. Robert T. Hill. An account of the extent of development, the speculation, etc., with a statement concerning the geological conditions. 2800 w. Mfrs' Rec—May 30, 1901. No. 41314.

The Poverty Bay Oil-Bearing Area. Extracts from the progress report of the Government Geologist. 2700 w. N Z Mines Rec—April 16, 1901. No. 41520 B.

Pan-American.

Mining Features of the Pan-American Exposition. I. The Dedication Ceremonies, by Edward W. Parker; II. The Mines Building and Mining Exhibits, by Dr. David T. Day; III. A Tour Through the Building, by Joseph Hyde Pratt; IV. The Petroleum Exhibit, by Harriet Connor Brown; V. Mining Statistics as Shown at Buffalo. Ill. 3500 w. Min & Met—June 1, 1901. No. 41539.

Quicksilver.

The Quicksilver Mines of Brewster County, Texas. E. P. Spalding. An illustrated account of these valuable deposits, the method of prospecting, production, etc. 2000 w. Eng & Min Jour—June 15, 1901. No. 41566.

Sapphires.

Sapphire Mines of Montana. An illustrated account of these valuable gem mines, the methods of working stones found, etc. 1500 w. W Min Wld—June 1, 1901. No. 41429.

Tasmania.

Mining in Eastern Tasmania. H. Grant. An account of the tin mining, the deposits and their development. 3500 w. Aust Min Stand—May 9, 1901. No. 41627 B.

Zinc.

The Zinc Combine. Editorial discussion of the combination of European zinc producers. 1000 w. Engng—May 3, 1901. No. 40848 A.

RAILWAYS AND TRAMWAYS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April. Detailed list and classified summary. Also information concerning the I. C. C. accident reports. 4700 w. R R Gaz—June 7, 1901. No. 41537.

Collisions.

Oil-Car Collisions. Editorial discussion of recent collisions with oil trains. 1100 w. R R Gaz—June 21, 1901. No. 41822.

Derailments.

Car Trucks, Car Wheels, and Derailments. Editorial discussion of certain features in connection with the design of rolling stock. 1700 w. Eng News—June 20, 1901. No. 41814.

Freight Handling.

Unloading a Heavy Shaft. Illustrated directions for safely unloading a crank shaft, skidded and lying on a flat car. 3000 w. Power—June, 1901. No. 41427.

Interurban.

Some Observations on Interurban Electric Railways. Walter J. Sherman. Reviews briefly the pioneer work in this field, and discusses the present problem of furnishing rapid transit and give satisfactory earnings. 1800 w. Trans Assn of Civ Engrs of Cornell Univ—1901. No. 41-389 D.

Pan-American.

The Pan-American Exposition. General remarks on the exposition, with illustrated description of the transportation exhibits. 7800 w. Ry & Engng Rev—June 15, 1901. No. 41662.

Train Resistance.

Center Plate Friction and Its Effect on Wheel Flange Resistance. Willis C. Squire. A discussion of experimental investigations and their results. Also tables and general discussion. 7800 w. W. Ry Club—May, 1901. No. 41800 C.

FINANCIAL.

Accounts.

Material Accounts. A. D. Parker. Address at meeting of the Assn. of Am. Ry. Accounting Officers. Describes the methods of handling material accounts, offering suggestions. 4000 w. Ry Age—June 7, 1901. No. 41553.

The Store Room and Store Room Accounts. Benjamin W. Tingley. Discusses methods of keeping accounts in the store rooms of street railways. 2500 w. St Ry Jour—June 1, 1901. No. 41414 D.

High Speed.

Cost of Running Trains at High Speed. Considers the cost of running trains at high speed as affected by mechanical considerations. 4800 w. Am Ry Mas Mechs' Assn—Saratoga meeting, 1901. No. 41-623 C.

Train Speeds.

Economical Train Speeds. G. R. Henderson. Diagrams showing results of experiments from the fuel standpoint, with explanatory notes. 1800 w. Am Engr & R R Jour—June, 1901. No. 41436 C.

MOTIVE POWER AND EQUIPMENT.

Accumulators.

Storage Battery Auxiliaries. Lamar Lyndon. Describes the various booster systems in use and shows the conditions to which each is suited. 2000 w. Elec Wld & Engr—June 8, 1901. No. 41548.

Air Brakes.

The Maintenance of Air Brakes on Freight Cars. G. W. Rhodes. Considers what methods should obtain to insure the cleaning of triples at least once in every 12 months; and should there be few or many cleaning stations on a railroad or system of railroads. 1300 w. Am Engr & R R Jour—June, 1901. No. 41435 C.

Berlin.

Electric Driving on the Berlin Belt Railway (Der Elektrische Betrieb auf der Berliner Stadt und Ringbahn). D. Pforr. An examination of the conditions of operation of the Berlin municipal railway in view of the substitution of electric driving for steam. 2200 w. Glasers Annalen—June 1, 1901. No. 41725 D.

Brake Shoes.

The Friction of Brake Shoes. R. A. Parke. Reviews experiments to date, and discusses the effect of pressure, speed, continued rubbing, temperature, etc. 8000 w. R R Gaz—June 14, 1901. Serial. 1st part. No. 41650.

Buffalo Railways.

The Street Railways of Buffalo and Vicinity. Illustrated description of the lines of the International Traction Co., their operation and connecting lines. 14000 w. St Ry Rev—June 15, 1901. No. 41-666 C.

Car Building.

Steel in Car Building. John M. Housen. On the advantages of the steel underframe. 2000 w. R R Gaz—June 14, 1901. No. 41640.

Car Construction.

Pressed Steel System of Car Construction. An estimate of the economies realized by the use of steel cars. Ill. 2200 w. Sci Am—June 22, 1901. No. 41695.

Car Heating.

The Heating of Railway Cars (Le Chauffage des Voitures de Chemins de Fer). H. Guérin. An exhaustive review of the great improvements in heating railway carriages in France as shown by the expositions of 1889 and 1900. Three articles. 6000 w. Génie Civil—May 18, 25, June 1, 1901. No. 41702 each D.

Car Motoring.

Four Motors v. Two. Reviews ideas advanced in the papers of Messrs. Pestell and Bigelow, and discusses the subject from the English viewpoint. 2300 w. Elec Rev, Lond—May 31, 1901. No. 41489 A.

Cars.

80,000-lbs. Capacity Box Car—Central of Georgia. Illustrated description of one of 300 cars now being built from this design. 1200 w. R R Gaz—June 21, 1901. No. 41820.

80,000-lbs. Capacity Steel Dump Car—Atchison, Topeka & Santa Fe. Illlustrated description. 800 w. R R Gaz—June 14, 1901. No. 41647.

New Parlor and Cape Dining Cars, B. & O. R. R. Half-tone illustrations and floor plant, with description. 400 w. Ry & Engng Rev—June 22, 1901. No. 41849.

New Passenger, Dining and Observation Cars. Brief illustrated descriptions of a few examples of recent design. 1100 w. Eng News—June 20, 1901. No. 41812.

100,000-lb. Ore Car; Chicago, Milwaukee & St. Paul Ry. Illustrated detailed description. 1000 w. Eng News—June 20, 1901. No. 41817.

Philadelphia & Reading Box Cars with Steel Underframes. Illustrated description of a design for 500 box cars of 50,000-lbs. capacity. 1200 w. R R Gaz—June 21, 1901. No. 41821.

The Ingoldsby Dumping Car. Illustrates and describes both the steel and wood construction. 1400 w. Ry & Engng Rev—June 22, 1901. No. 41850.

Car Ventilation.

New Ventilating System for Passenger Cars. Illustrates and describes with some detail, the system which has been applied to over 200 cars of the Pennsylvania Railroad. 5000 w. Am Engr & R R Jour—June, 1901. No. 41437 C.

Car Wheels.

The Further Development of Cast Iron Wheels. S. P. Bush. Suggestions for the improvement of the wheels by a change in the contour. 800 w. R R Gaz—June 14, 1901. No. 41646.

Cleveland, Ohio.

Improvements on the Cleveland Electric Railway. Illustrated description of the interesting features. 1300 w. St Ry Jour—June 1, 1901. No. 41416 D.

Couplers.

The Freight Car Coupler Situation. Edward Grafstrom. Discusses drop testing machines, the coupler contour gauge, the "angling test," etc. 1300 w. Ry Mas Mech—June, 1901. No. 41316.

Coupler Tests.

Tests of the M. C. B. Couplers. Report of the standing committee concerning the tests of the last year. 4300 w. Am Mast Car Bldrs' Assn—Saratoga meeting, 1901. No. 41621 C.

Draft Gear.

The Draft Gear Situation. Edward Graftstrom. Discusses recent tests and what they demonstrate; also a reply to this article in a letter from E. M. Herr. 2400 w. Am Engr & R R Jour—June, 1901. No. 41447 C.

Electric Traction.

Electric Traction on Main Line Railways (Der Elektrische Betrieb von Vollbahnen). Fr. Ross. With especial reference to the operation of the section of the Valtellina Railway, between Lecco and Chiavenna by electric locomotives, using the hydraulic power of the Adda. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—May 24, 1901. No. 41718 B.

The Ganz Electric Line of Valtellina. Illustrated description of a line representing the highest development of the Ganz three-phase high-tension system of electric traction. 800 w. Sci Am—June 29, 1901. No. 41863.

Fireboxes.

Wide Fireboxes for Soft Coal. F. A. Delano. A review of recent changes in the designs of fireboxes and why they were made. 1200 w. Am Engr & R R Jour—June, 1901. No. 41438 C.

Freight Cars.

Comparative Efficiencies of Freight Cars, With Some Observations Concerning Their Design. George I. King and Albert Pancoast. Discussion of this subject, with observations on car design in general and a plea for designs in accordance with known laws and facts of structural and mechanical engineering. 2000 w. R R Gaz—June 14, 1901. No. 41654.

Fuel Consumption.

Saving in Fuel Consumption by the Compound Locomotive. C. J. Mellin. Gives a table showing the results collected from various records of performances in regular service and road tests, with comments. 800 w. R R Gaz—June 14, 1901. No. 41645.

What Is the Most Promising Direction in Which to Effect a Reduction in Locomotive Fuel Consumption. Report of the committee concerning methods worthy of consideration. 5700 w. Am Mas Mech Assn—Saratoga meeting, 1901. No. 41620 C.

Glasgow.

Glasgow's Tramway System. A. C.

Shaw. Reviews the history of Glasgow's tramways, and gives an illustrated detailed description of the recently installed electrical equipment. 9000 w. St Ry Jour—June 1, 1901. No. 41412 D.

The Glasgow Corporation Electric Tramways. An illustrated account, giving a summary of the principal facts in regard to the station and equipment. 4500 w. Tram & Ry Wld—May 9, 1901. No. 41351 B.

Grate Areas.

Grate Areas for Burning Culm. T. S. Lloyd. Gives table of fuel tests, and discusses the practice on the D. L. & W. R. R. 1500 w. Am Engr & R R Jour—June, 1901. No. 41445 C.

Locomotive Driving.

The Question of Alternating Locomotive Engineers (Zur Frage des Wirthschaftlichen Nutzens der Doppelbesetzung der Lokomotiven). M. Herrmann. An examination of the advantages of alternating engineers for locomotives in place of leaving the engine to a single operation. 3000 w. Glaser's Annalen—June 1, 1901. No. 41726 D.

Locomotive Fuel.

Burning Crude Oil in Locomotives. From the discussion of W. N. Best, at the last meeting of the Pacific Coast Ry. Club. Considers types of burners, means of securing perfect combustion, etc. 2000 w. R R Gaz—June 21, 1901. No. 41819.

Locomotives.

American Locomotives in England. Charles Rous-Marten. An article in defense of the American engines, and showing the injustice of the comparison recently made with British engines. 3000 w. Engr, Lond—June 14, 1901. No. 41839 A.

An Improved Cast Steel Locomotive Frame. Robert M. Galbreath. Also editorial. A statement of the several features of the steel frame question, with illustrated description of design and record of wear of driving boxes. 3000 w. R R Gaz—June 14, 1901. No. 41648.

C. B. & Q. Inspection Locomotive. Illustrated description. 600 w. Ry & Engng Rev—June 8, 1901. No. 41551.

Erie Class H-12 Consolidation Locomotive. Illustrated detailed description. 800 w. R R Gaz—June 14, 1901. No. 41644.

European Railway Jottings. Illustrated descriptions of a small tank engine used about the year 1850, and two of the latest arrivals among the British express engines. 3000 w. Loc Engng—June, 1901. No. 41431 C.

Express Engine, London, Brighton, and South Coast Railway. Illustration and principal dimensions with remarks. 1000 w. Engr, Lond—June 7, 1901. No. 41615 A.

Intercolonial Locomotives With Cleveland Cylinders. Illustrated description of one of the passenger engines, recently ordered from the Dickson Locomotive Works. 1700 w. R R Gaz—June 14, 1901. No. 41642.

Italian Express Locomotive. Illustrates details of this high-speed compound locomotive giving dimensions. 800 w. Engng—June 14, 1901. No. 41835 A.

Locomotive Progress. Annual review of changes in design and progress in construction. 1400 w. Ry Mas Mech—June, 1901. No. 41315.

New Type of Freight Locomotives for the Chicago, Burlington & Quincy R. R. Illustrates and describes the new "Prairie" type of engines under construction for this road. 1700 w. Eng News—May 30, 1901. No. 41307.

Richmond Locomotives for Finland. Illustrated description of the ten-wheel locomotives for the State Railways. 800 w. Ry Age—May 31, 1901. No. 41421.

Six-Coupled Compound Express Engine, Mediterranean Railway of Italy. Dimensions and some constructional details of this engine. 3700 w. Engr, Lond—May 31, 1901. No. 41495 A.

The "De Glehn" Compounds on the Northern of France. R. Hope. Records of the actual performances of these engines, with remarks. 2700 w. R R Gaz—June 7, 1901. No. 41535.

Vanderbilt Locomotive and Tender—Illinois Central Railroad. Illustrated description of a ten-wheel freight locomotive on exhibition at the Pan-American Exposition, which is attracting much attention. 1200 w. R R Gaz—May 31, 1901. No. 41313.

Wide Firebox Locomotives. An illustrated account of the development in the direction of increased grate surface. 4300 w. Ry Age—June 14, 1901. No. 41660.

Los Angeles.

Recent Work of the Los Angeles Railway. Illustrates and describes features of interest. 2000 w. St Ry Jour—June 1, 1901. No. 41413 D.

Mileage.

Should Engine Ton Mileage Be Included in Motive Power Statistics? C. H. Quereau. Discusses this question at some length. 4000 w. Am Engr & R R Jour—June, 1901. No. 41446 C.

Old Cars.

Method of Utilizing Old Street Cars. Illustrated descriptions of old cars utilized as dwellings and an account of quite a settlement formed in this way at the seaside in California. 900 w. Sci Am—June 29, 1901. No. 41864.

Oil Fuel.

Oil Burning on Locomotives. Extracts from answers to questions bearing on this subject presented before the Pacific Coast

Ry. Club. 2800 w. Ry & Engng Rev—June 15, 1901. No. 41663.

Private Car.

A Unique Private Car. Illustrated description of a car built for the general manager of the Union Traction Co., of Indiana. It is an office and home on wheels. 500 w. Ry Age—June 14, 1901. No. 41659.

Power House Design.

The Steam Features of Electrical Power House Design. F. W. Dean. Considers the boiler plant and the use of water-tube boilers, and things of importance to secure economy; the choice of engines, the steam pipes, and related equipments. 4600 w. R R Gaz—June 14, 1901. No. 41652.

Rolling Stock.

Rhodesian Railway Rolling-Stock. Illustrated description of the *train de luxe* for this road. 900 w. Engng—May 31, 1901. Serial. 1st part. No. 41502 A.

Sheffield, Eng.

The Equipment of the Sheffield Electric Tramway System. A. L. C. Fell. Read before the Northern & Midland Co.'s Assn. Illustrates and describes points of interest in the equipment. 2700 w. Tram & Ry Wld—May 9, 1901. No. 41352 B.

Shop Equipment.

Power Equipments for Railroad Shops. George A. Damon. A consideration of the important things to examine before reaching a conclusion in the problem of supplying a modern railroad shop with an up-to-date power equipment. Ill. 3300 w. R R Gaz—June 21, 1901. Serial. 1st part. No. 41818.

Steel Axles.

The Chemical Composition of Steel Freight Axles. William Forsyth. Remarks showing that the steel manufacturers favor an axle steel which is higher in carbon than the present M. C. B. limits. 700 w. R R Gaz—June 14, 1901. No. 41653.

The Chemistry and Manufacture of Steel Axles. C. E. Middleton. Considers the chemical composition and the improved methods of manufacture which have greatly reduced the sources of trouble. 1300 w. R R Gaz—June 14, 1901. No. 41641.

St. Helen's.

St. Helen's Electrical Tramways. Illustrated description of one of the first lines in England to adopt electricity. 2300 w. Tram & Ry Wld—May 9, 1901. No. 41350 B.

Test Car.

Railway Test Car No. 17, Univ. of Illinois and Ill. Cent. R. R. Edward C. Schmidt. Illustrations and account of the performance of this test car during its nine months of service. 1300 w. Ry. & Engng Rev—June 1, 1901. No. 41410.

Trucks.

Rigid vs. Swing Center Car Trucks. F. P. Roesch. The writer explains and proves his theory that the rigid cars pull harder, weight for weight, than the swing-truck and loose drawbar car. 1600 w. Loc Engng—June, 1901. No. 41432 C.

Water Treatment.

Some Phases of the Water Treatment Problem. Howard Stillman. A study of the treatment of water for locomotive use only. 1600 w. Am Engr & R R Jour—June, 1901. No. 41443 C.

NEW PROJECTS.

Abyssinia.

The Railway from Djibonti to Harrar (Le Chemin de Fer de Djibonti au Harrar). A. Dumas. A description of the railway now under construction from Djibonti on the Gulf of Aden to Harrar and to Addis-Abeba, the capital of Abyssinia. 3500 w. 1 plate. Génie Civil—May 25, 1901. No. 41704 D.

Africa.

The Kumasi Railway. Information and illustrations of this road under construction. 800 w. Engng—May 31, 1901. No. 41499 A.

Connecting Line.

The Liske and Looe Railway. An account of a line just opened, joining this line with the Great Western Railway. 1200 w. Transport—June 7, 1901. No. 41624 A.

Incline.

The Montmartre Inclined Railway. From *La Nature*. Illustrated description of a railway in Paris constructed to save people the tiresome climb of 220 steps necessary to reach the cathedral. 1000 w. Sci Am Sup—June 1, 1901. No. 41289.

Japan.

Railways in Japan. Information concerning the railway situation at the end of 1899. 600 w. U S Cons Repts, No. 1057—June 8, 1901. No. 41374 D.

Mono-rail.

The Manchester and Liverpool Express Railway. Editorial discussion of the proposed thirty-five mile line on the mono-rail system, which is to cover the distance in twenty minutes. 1500 w. Engr, Lond—May 24, 1901. No. 41363 A.

Monorail.

The Monorail Railway. Editorial discussion of the scheme to construct a monorail railway between Liverpool and Manchester. 3000 w. Engng—May 31, 1901. No. 41503 A.

Tasmania.

The Great Western Railway of Tasmania. An account of the proposed construction of a railway for the development of a portion of this island. Map. 2000 w. Transport—May 29, 1901. No. 41347 A.

PERMANENT WAY AND FIXTURES.

Culverts.

The Design of Arch Culverts. Daniel B. Luten. Illustrates and describes the standard designs adopted by most American railways and presents the advantages of the flat arch. 1400 w. Eng News—June 13, 1901. No. 41581.

Curves.

Holbrook's Spiral Curves. E. Holbrook. An explanation of the actual work in the field, giving tables and figures. 1700 w. Eng News—June 13, 1901. No. 41580.

Elevator.

Hydraulic Elevator for Railway Carriages. (Ancenseur Hydraulique pour Wagons.) Illustrated description of new hydraulic lift at the Rome-Trastevere station of the Mediterranean Railway of Italy. 800 w. 1 plate. Génie Civil—May 18, 1901. No. 41701 D.

Java.

Some Difficulties with the Railways of Java (En Zijne Bemoeiingen met de Spoorwegen op Java). J. P. de Bordes. A review of the work upon the railway of Java and the difficulties encountered in their construction by the late chief engineer. 10000 w. Tidschr v h Kljk Inst van Ing—Feb. 9, 1901. No. 41763 H.

Rail-Bonds.

Concerning Rail-Bonds. Samuel Sheldon. Outlines the common methods employed, and remarks on the importance of perfect work and frequent inspection. 1400 w. St Ry Jour—June 1, 1901. No. 41-415 D.

Return Cables vs. Rail Bonding. Alton D. Adams. Discusses these two systems showing the bonded system cheaper in first cost, but so much more expensive in maintenance as to make it soon exceed the cable system. 2400 w. Marine Engng—June, 1901. No. 41399 C.

Rail Joint.

The Bochum Rail Joint (Bochumer Schienenstoss-Verbindung). J. Grimme. Describing and illustrating a form of bridge rail joint especially adapted for tramway service. 1000 w. Schweizerische Bauzeitung—May 11, 1901. No. 41756 B.

Roundhouse.

An Up to-Date Roundhouse. Report of the committee of the American Railway Master Mechanics' Association. Ill. 3000 w. Am Mas Mech Assn—Saratoga meeting, 1901. No. 41619 C.

Shop.

Sandou Engine Works. An illustrated description of the new erecting shop and its equipment. 3000 w. Engr, Lond—June 14, 1901. No. 41841 A.

Shop Extensions.

Topeka Shop Extensions. R. P. C. Sanderson. Illustrated account of extensive shop improvements on the A., T. & St. F. Ry. 3000 w. Am Engr & R R Jour—June, 1901. No. 41440 C.

Station.

A New Passenger Station in Chicago. Illustrated description of the accepted plans for a station at Van Buren street. 1600 w. Ry Age—June 14, 1901. No. 41658.

Artistic Suburban Stations. Illustrates examples in the vicinity of Chicago. 600 w. Ry Age—June 14, 1901. No. 41661.

Pittsburgh & Lake Erie Station at Pittsburgh. Illustrates and describes one of the finest passenger stations in the United States. 1200 w. R R Gaz—June 7, 1901. No. 41536.

The Sullivan Square Station, Boston. Illustrated description of a double-deck train shed at one of the terminals of the Boston Elevated Ry., and of a large number of electric railways. The roof arches have a span of 175 ft. 1700 w. Eng Rec—June 15, 1901. No. 41563.

Steel Rails.

Specifications for Steel Rails. Continued discussion of Mr. Webster's paper. 2400 w. Trans Am Inst of Mine Engrs—June, 1901. No. 41680 D.

Switch.

The Vaughan Split Switch. Illustrated detailed description of this design. 700 w. Ry & Engng Rev—June 22, 1901. No. 41848.

Ties.

The Making of Railroad Ties. Aloysius Coll. Information in regard to the cutting and preparation of the ties, their transportation, etc. 2200 w. Am Mfr—May 30, 1901. No. 41297.

Track Tanks.

The Feeding of Locomotives in Motion (Alimentation des Locomotives en Marche). A general review of the devices for taking up feed water for locomotives from tanks between the rails, with details of the methods used on the French railways. 2000 w. 1 plate. Génie Civil—June 8, 1901. No. 41708 D.

Uganda.

Physical and Economic Features of the Uganda Railway. F. W. Emett. A fully illustrated account of this forerunner of civilization and traffic into the heart of Africa. 3500 w. Engineering Magazine—July, 1901. No. 41775 B.

Unloaders.

Automatic Unloaders (Selbstentlader). M. Buhle. Illustrating and describing various forms of cars for tipping and dumping earth, including both American and German designs. 2000 w. Zeitschr d Ver Deutscher Ing—May 25, 1901. No. 41-713 D.

TRAFFIC.

Coal Consumption.

Locomotive Coal Consumption. M. N. Forney. Brief discussion of the available sources of economy in fuel consumption. 1200 w. Am Engr & R R Jour—June, 1901. No. 41439 C.

Engine Rating.

The Basis of Engine Rating. J. Shirley Eaton. Discusses methods of tonnage rating. 2800 w. R R Gaz—June 14, 1901. No. 41643.

Exposition Crowds.

Handling Pan-American Exposition Crowds on the Buffalo Railway. Illustrates and describes the arrangements made for the transportation and control of large crowds. 900 w. St Ry Jour—June 1, 1901. No. 41417 D.

Heavy Service.

Best Type of Engine for Heavy Fast Passenger Service. F. F. Gaines. Discusses the best type as regards wheel base arrangements. Ill. 1200 w. Am Engr & R R Jour—June, 1901. No. 41444 C.

Electricity v. Steam for Heavy Railway Service. L. D. Tandy. A comparison of lines in operation in the United States, showing the advantages over steam and the saving in operating expenses. Ill. 5000 w. Tram & Ry Wld—May 9, 1901. No. 41349 B.

Prussia.

The Development of the Railways of Prussia from 1890 to 1900 (Die Enturckelung des Eisenbahnwesens in Preussen 1890 bis 1900). Statistical data from the report of the Department of Public Works. 1800 w. Glückauf—May 18, 1901. No. 41731 B.

Tonnage Rating.

Practical Tonnage Rating. George R. Henderson. Presents rules and diagrams by the use of which the writer believes it will be possible to rate almost any modern engine on any profile and alignment, and with very few calculations to establish a satisfactory schedule. 3500 w. Am Mas Mechs' Assn—Saratoga meeting, 1901. No. 41622 C.

MISCELLANY.

Electrolysis.

See Civil Engineering, Water Supply.

Statistics.

The Railroads of the World. Tabulated information compiled and reduced from statistics published in the *Archiv für Eisenbahnwesen*, with editorial. 2000 w. R R Gaz—May 31, 1901. No. 41310.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to JOHN R. DUNLAP, PUBLISHER.

Coal Mining.

Elementary Text Book of Coal Mining. By Robert Peel. Pp. 300. Price $1.00. London: Blackie & Son. Philadelphia: J. B. Lippincott Co.

A text book for the classes in coal mining of the Science and Art Department, also forming a convenient handbook for those attending lectures upon mining. The book gives much general information upon the subject of coal mining, but is confined mainly to British practice and methods.

Electricity.

Alternating Currents. An Analytical and Graphical Treatment for Students and Engineers. By Frederick Bedell and Albert C. Crehore. Size 6 in. by 9 in.; pp. 325. Price $2.50. New York: *Electrical World and Engineer.*

The fourth edition of Bedell and Crehore's well-known work. Part I contains the analytical treatment, discussing circuits containing resistance, self-induction and capacity, with the solution of problems. Part II discusses the same problems graphically, while appendices containing electrical units, and mechanical and electrical analogies, are added.

Marine Engineering.

Practical Advice for Marine Engineers. By Charles W. Roberts. Pp. 150. Price 75 cents. London: Whittaker & Co.; New York: The Macmillan Co.

A practical handbook, especially intended for junior engineers, desirous of advancing themselves by acquiring a thorough knowledge of marine engineering.

Oil Engines.

The Design and Construction of Oil Engines. With Full Directions for Erecting, Testing, Installing, Running, and Repairing. By A. H. Goldingham, M. E. Price $2.00, 7s. 6d. Size 5 by 7½ in.; pp. 196. New York: Spon & Chamberlain; London: E. & F. N. Spon, Ltd.

The book, as its title suggests, is intended for draughtsmen, oil-engine attendants, or those owning or about to install oil engines, its purpose being to supply sufficient knowledge of principles to insure intelligent practical work. The treatment of vaporization, ignition, and valve mechanism is just full enough to make clear the much fuller following chapters on designing, testing, and running oil engines for varied service. A brief description of each of the principal types of oil engines is given.

Roads.

Road Making and Maintenance. A Practical Treatise for Engineers, Surveyors, and Others. By Thomas Aitken. Pp. 440. Price $6.00. London: Charles Griffin & Co.; Philadelphia: J. B. Lippincott Co.

A comprehensive treatise from the quarrying of the material to the completion and maintenance of the road. The question of crowded city traffic is discussed and a large portion of the book is devoted to the construction of carriage-ways and footpaths.

Rivers.

Profiles of Rivers in the United States. By Henry Gannett. Size 6 by 9 in.; pp. 100. With map and 11 plates of river profiles. U. S. Geological Survey, Washington, D. C., U. S. A.

No. 44 of the series of Water-Supply and Irrigation papers. A very important publication. The profiles are given in tabular form in the body of the paper, each prefixed by a general description of the river and citation of the authority for the figures presented. In the plates, the profiles are represented graphically on a uniform scale. A discriminating introductory discussion calls attention to the varying accuracy of the various sources of information from which the data are drawn.

Sea-Beach.

The Sea-Beach at Ebb Tide. By Augusta Foote Arnold. Size, 5½ by 8 in.; pp. 490. Ill., 600. Price, $2.40 net, $.20 postage. New York: The Century Company.

An excellent working manual for the identification, preliminary study, and collection of the animal and vegetable forms found on the coasts of the United States. It is addressed to those who are intelligently or even casually interested in the seaweeds, polyps, sponges, shells, crustaceans, and other types of life of the beaches and tide-pools. Without presupposing any technical study on the reader's part, it is soundly scientific in arrangement and method. Its plain language and

copious illustration make it thoroughly serviceable to the amateur, while its orderly arrangement gives a true idea of the relation and systematic grouping of the species described. A satisfactory and valuable hand-book of reference for the seaside.

Steam Engineering.

An Elementary Text Book of Steam Engines and Boilers. By J. H. Kinealy, Professor of Mechanical Engineering at Washington University. Price, $2.00, 7s. 6d. Size, 6 by 9 in.; pp. 259. Third edition. New York: Spon & Chamberlain; London: E. & F. N. Spon, Ltd.

Professor Kinealy's text book has been revised, corrected, and in part rewritten for this edition. It deals with the subject entirely from the theoretical side, treating of elementary thermodynamics, the theory of the steam engine, types of engine, admission of steam by valves, valve diagrams and indicator cards, compounding and condensing, combustion of fuel, types of boilers, etc., in the manner of an authoritative text book for students.

Steam Engineering.

How to Run Engines and Boilers. With a New Section on Water-Tube Boilers. By Egbert Pomeroy Watson. Fifth edition. Price $1.00, 4s. Size, 4¼ by 6½ in.; pp. 160. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

A revision of the fourth edition of this excellent little manual of "practical instruction for young engineers and steam users." It accomplishes admirably its purpose—to give the inexperienced a clear, comprehensive statement of the first principles and practical rules of management and maintenance of the boiler and engine. It is treated from the standpoint of the man in practical charge of the steam plant, with enough explanation of theory to make clear the reasons for the rules of practice.

Stream Gaugings.

Operations at River Stations, 1900. A Report of the Divisions of Hydrography of the U. S. Geological Survey. Part I. Size, 6 by 9 in.; pp. 99. U. S. Geological Survey, Washington, D. C., U. S. A.

Pamphlet No. 47 in the series of Water-Supply and Irrigation papers, giving descriptions of the river stations maintained by the U. S. Geological Survey, with details of average daily height of water and measurements of discharge, affording very valuable assistance for the estimation of available power on the larger streams of the United States. The tabulated measurements, arranged by States, are prefaced by sections on the use of stream gaugings for computation of water power, on the measurement of sediment, and a most interesting one on tests of the accuracy of discharge measurements as made in the N. Y. State canal surveys by Mr. E. Kuichling and Professor G. S. Williams. The law limiting these papers to 100 pages each has compelled division of the material. The pamphlet in hand is devoted to New England and Eastern streams. Succeeding papers take up rivers flowing into the Atlantic Ocean, those of the Ohio and Mississippi valleys, the Great Lakes, Missouri and Rio Grande, interior basin, Pacific, and Southern California.

Telephony.

ABC of the Telephone. By James E. Homans, A. M. Price, $1.00. Size, 5 by 7½ in.; pp. 335. New York: Theo. Audel & Co.

An elementary and general treatise, designed particularly for the student and worker in telephony and for laying the foundations for specialized technical study of the subject. The language is adapted to the non-professional reader; the treatment is largely descriptive of apparatus and practice. Six chapters deal with history and general principles; Chapter VII discusses the transmitter; Chapter VIII, the circuits of the apparatus; Chapter IX to XV, switches and switchboards; Chapter XVI to XX, line systems and signals; Chapters XXI to XXVI, line and cable construction and protection; Chapters XXVII and XXVIII, miscellany.

Wages.

Les Salaires dans l' Industrie Gantoise. I. Industrie Cotonnière. Par Louis Varlez. Size 6 in. by 9in.; pp. 590. Price 8 francs. Bruxelles: S. Lebègue et Cie.

The first volume of an exhaustive study of the wages of operatives in the various industries of Ghent. The volume is a portion of an official inquiry into industrial conditions, and is devoted to the cotton industry, including history, hours of labor, rates of wages at various periods, comparisons with other countries, etc., with numerous diagrams and tables.

Water Flow.

New Tables for the Complete Solution of Ganguillet's and Kutter's Formula for the Flow of Liquid in Open Channels, Pipes, Sewers, and Conduits. By Col. E. C. S. Moore, R. E. Size, 6 in. by 9 in.; pp. 231. Price, 15 shillings. London: B. T. Batsford.

A very elaborate set of tables giving values of the coefficients for 1,080 inclinations, ranging from 1 over 1, to 1 over 21,150 for 15 different values of the coefficient of roughness n. These tables will save an immense amount of computation for hydraulic engineers, and cover almost all conditions occurring in actual practice.

IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Shanghai, China, Exchange.

By courtesy of the Ericsson Telephone Co., New York, we illustrate the first sections of a telephone switchboard installed at Shanghai, China, and recently placed in operation. This is a full multiple board made by L. M. Ericsson & Co., Stockholm, Sweden, and the ultimate capacity is 5,000 subscribers. While the chief, who is a lady operator, went from Sweden with the switchboard, the others are all natives. It is said that they are remarkably apt in learning to operate, quick in their movements and naturally patient and persistent, and they readily become expert operators.

The operation of the Ericsson full multiple switchboard is extremely simple, each section being divided into five panels for convenience, and in large boards an annex is placed at each end. The plugs and cords are placed on two different planes, the answering below and the calling above—a great advantage to the operator, as the answering jacks are just above the answering plugs, thus separating them entirely from the calling plugs and multiple jacks. In case of a call the operator answers and can connect directly from her own division with any other subscriber in the board, thus giving very quick service and saving the time of the calling subscriber and of the other operators.

Each operator has eighteen pairs of cords and plugs, which provides for the busiest exchanges. The board is so made that busy subscribers' lines can be removed from one operator to another, thus distributing the work quite evenly. Each

operator has a counter, which records automatically all the outgoing calls from her division of the board.

It is said that this will be made a model exchange, and additional sections are on the way to Shanghai now, which will increase the size of the board; other sections are to be supplied as may be required. As switchboards of this same pattern are already in operation in the United States, the Ericsson Co. will take pleasure in giving further information to those who are interested.

Lunkenheimer Standard Injector.

THIS injector embodies in its construction all those desirable features which go to make an injector high grade and efficient. Realizing the demand for a high-class injector the "99 Model" has been designed and the manufacturers believe that they combined in its construction certain features which are not found in any other machine. Before placing it on the market it has been tested under a variety of conditions of severe service during the past year, and has proved itself of superior efficiency and durability. The construction is simple, manipulation easy, and the results attained show a high degree of efficiency.

It can be started promptly under most conditions at all pressures from thirty pounds to two hundred and fifty pounds, and it can be handled without fear of uncertainty of action, as it is not sensitive. It will work without adjustment of steam or water from forty to two hundred and fifty pounds and higher, and the capacity can be reduced over fifty per cent. at all points. This feature makes it especially suitable for severe service, as on railroads, steamboats, and other places where the load varies and it is necessary to have an injector the capacity of which can be reduced within wide limits.

The regulation of the amount of water delivered is accomplished in a very ingenious manner, and, in this respect, it differs from all other injectors. In the Lunkenheimer '99 Model injector, when the water discharge is reduced, the steam consumption is also reduced in direct proportion. In

other injectors the water supply alone is reduced, while the quantity of steam discharged remains constant. From this it will be seen that the temperature of the water discharged from the Lunkenheimer injector is much cooler, and, in places where water is used which contains scale-forming substances, these will not deposit as readily as if the discharge were hot.

This injector is of the positive class; that is, when it is in operation the overflow valve is held to its seat and the water is all forced into the boiler. As the lifting and forcing tubes are combined in one line, the number

of parts is minimized for this class machine, and the only tube subject to any degree of wear is the forcing combining tube. This tube, however, owing to its proportions with respect to those of the other tubes, and also on account of the absence of spill holes in walls of same, possesses great durability, and, when worn to any extent, can be renewed very easily at slight expense. All the tubes are screwed in from one direction; thus they can be readily removed for examination or replacement without in any way disturbing the pipe connections or dismantling the injector other than removing the steam valve bonnet.

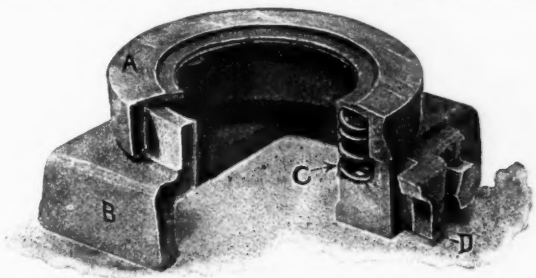
The injector is well proportioned throughout; the operating mechanism which controls the steam and overflow valves is not complicated and is contained within the injector body. All valves are so placed that they are easily accessible for examination or repairs. The body casting is in one piece, and, as explained before, the arrangement of the tubes will be found very satisfactory, for, in order to remove same, it is not necessary to take the body apart, as is the case with certain other makes. The form of the body is handsome and neatly designed and presents a very attractive appearance. The line check valve is of the swing pattern, which gives full waterway, and, when worn in the seat, can be reground without removal from injector body.

Made by the Lunkenheimer Co., Cincinnati, Ohio.

New Balanced Valve.

THE requirements of steam users all over the country have brought out a number of ideas in the construction of balanced valves. We show herewith an illustration of one having a number of desirable features.

"B" represents the valve proper, similar to the ordinary "D" valve, except that a hub is cast upon the top. Over this hub is carefully fitted a telescopic relief plate, "A." This is machined on its upper face, which bears against the steam chest cover. It is held against this cover by means of springs, "C," inserted between the valve proper and relief plate. This construction enables the valve to remain steam tight even after wearing to a considerable extent. In



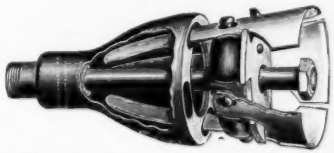
fact, the more they are run the better their operation. The valves are balanced to about 78 per cent. of their area.

The unbalanced part of the valve insures pressure on the seat sufficient to prevent leakage through the valve. Leakage through the relief plate cannot cause the engine to turn over as the steam passes directly out of the exhaust pipe.

This valve is used by the Erie Pump & Engine Company of Erie, Pa., in all of their engines.

A New Flue Cleaner.

WE illustrate herewith a flue cleaner which is the invention of La Fayette Rollins. Mr. Rollins has taken his idea from the ordinary funnel, inserting four blades into the mouth of the funnel and holding



them there by means of a core to which the blades are attached by riveting through a slotted opening. Any resistance causes these blades to be spread as the blade extension comes in contact with the narrow end of the funnel.

The mechanical construction appears to be perfect and the solidity or durability of the tool is apparent at first glance, there being no strain on any of the working parts except the body or funnel, and that is cast of solid metal in either brass or malleable iron. The blades are drop forged steel and in case of accident can easily be replaced. This device is adapted only to straight flues and is claimed to be equally effective either in smoke flues or water tubes.

The Stephenson Mfg. Co., of Albany, N. Y., are the sole agents. Interested parties can obtain further information by addressing them.

Cold Process Galvanizing.

THE preparations for the International Yacht Races draw attention to a development in galvanizing which is of interest to the iron and steel trades. The deck and other exposed metal parts of the yacht "Constitution" have been galvanized by the so-called "patent cold process" system in which the spelter is deposed electrically instead of by the usual dipping process. A saving of about 1,200 pounds in weight in construction was effected in galvanizing the deck and other exposed metal of the "Constitution"—an item of utmost Importance in the present case, and one impossible to accomplish by any other process. The electric or cold process presents the advantage of not changing the original character of the surface treated, graduations on scales or other instruments being as clearly marked as before being coated, while screw holes and perforations in artistic work are not filled up with useless metal. The free action of moving parts is retained, and the elasticity and temper of the articles treated are not in any way impaired, as proved by tests on corset steels, wire, springs, etc.

There is no limit apparently to the application of this process of galvanizing, and an interesting phase of it is the coating of the interiors of boilers to prevent corrosion. An example of the fineness of the coating of spelter is shown in the fact that bolts, nuts, screws, fittings, etc., need no recutting after galvanizing. The economy of the process is evident when it is considered that 80 to 90 per cent. of spelter is saved and there is no dross, which, by the old process, frequently consumes 30 to 50 per cent. of the zinc.

This is really the only process which is correctly entitled to be called "galvanizing," there being no galvanic action whatever employed in the old hot "dipping" process.

The cold process of galvanizing has been introduced in the New York Navy Yard at Brooklyn, and it is probable that all the other Government Navy Yards will be equipped with plants of similar kind. The Standard Oil Co., we believe, has discontinued altogether the old hot process plant and uses the cold process system entirely.

The proprietors of the process in the United States are the U. S. Electro-Galvanizing Co., 348 Broadway, New York, and they are prepared to issue licenses for shop rights, jobbing work, or sub companies for factories, cities, states, etc., on a royalty basis.

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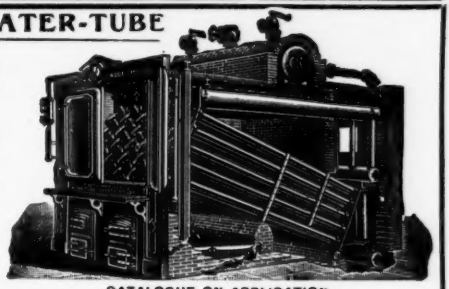

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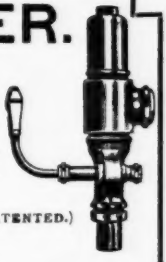

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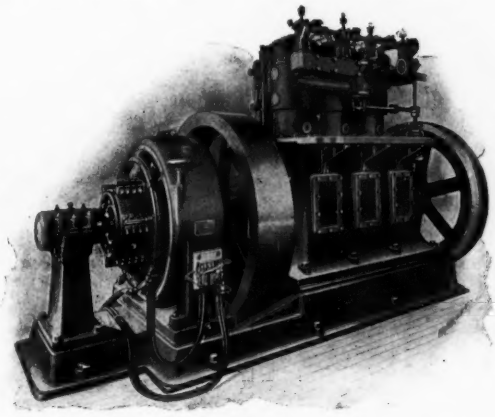

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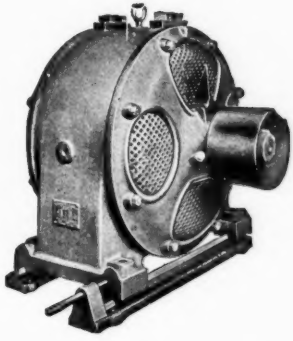

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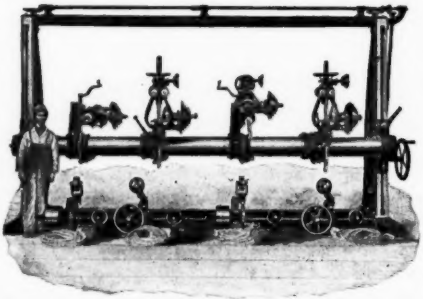

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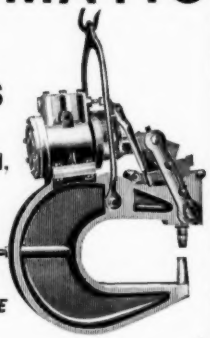

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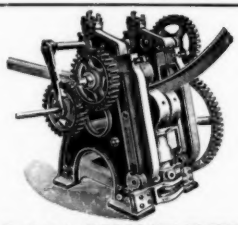

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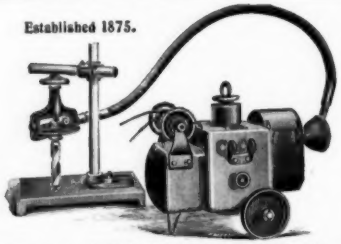

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